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COMPRESSOR RESEARCH FACILITY COMPUTER SYSTEM SUPPORT AND MAINTENANCE

BATTELLE MEMORIAL INSTITUTE
APPLIED TECHNICAL COMPUTER GROUP
WRIGHT-PATTERSON AFB OH 45433-7650

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13. ABSTRACT *(Maximum 200 words)*
Battelle supported the Air Force Compressor Research Facility from December 1990 to August 1996 under this contract. The work performed by Battelle included support to the information subsystem at the Compressor Research Facility located at Wright-Patterson Air Force Base. The work was largely computer related and included system administration; it entailed writing new software, modifying old software, and purchasing and integrating off-the shelf software packages. The work also included purchasing computer equipment and other hardware, helping the Air Force staff minimum manning positions during compressor testing, and training Air Force personnel in the use of newly developed software. Delivery orders covered test support, analysis, and other facility-related task.

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Abbreviations and Acronyms

ACF	Advanced Concept Fan
ADA	Analog Data Analysis
ADLARF	Advanced Damping Low Aspect Ratio Fan
APP1	Applications 1 (computer)
ATDS	Analog Tape Digitizing System
AUX	Auxiliary computer
Bld	building
CARL	Compressor Aerodynamic Research Laboratory
CDF	Core Driven Fan
CDROM	compact disk read-only media
CFD1	Computational Fluid Dynamics 1 (computer)
CPU	central processing unit
CRF	Compressor Research Facility
DAC	Data Acquisition Computer
DEC	Digital Equipment Corporation
DOD	Department of Defense
DVL	Development computer (DEC 3000-600S)
FCC1	Facility Control Computer 1
FCC2	Facility Control Computer 2
GESFAR	General Electric Swept Fan Assessment Rig
HPDAS	High-Performance Data Acquisition System
I/O	input/output
IBM	International Business Machines
ISO	International Organization for Standards
LAN	local area network
LAV	Laser Anemometer Velocimeter
LTA	Laser Transit Anemometer
Main	IBM 4381 (computer)
MON	Monitor (computer)
MUX	multiplexor
NES	network encryption server
NSP	network security panel
Oscopes	oscilloscopes
PCAL	pressure calibration
PERCH	performance evaluation for re-designing compressor hardware
PLC	programmable logic controller
POMIS	Aero Propulsion and Power Directorate Management Information System
PPX	Post-Processing VAX
RTU	remote tape unit
SCR	Signal Conditioning Room
SGI	Silicon Graphics Incorporated
SGMS	Strain Gage Monitoring System
SNS	secure network segment
TAC1	Test Article Control 1 (computer)
TAC2	Test Article Control 2 (computer)

TAG1	Test Article Graphics 1 (computer)
TAG2	Test Article Graphics 2 (computer)
TEFF	Turbine Engine Fatigue Facility
TRC	Turbine Research Center
TRF	Turbine Research Facility
US	United States
UTP	unshielded twisted pair
V6	VAX 6000
VS4	VAXstation 4000-90
WAN	wide area network
WPAFB	Wright-Patterson Air Force Base
XT	Xterminal
XTC66	Experimental Technology Core Pratt & Whitney 6th generation
ZAD	ZOC and Druck
ZOC	zero, operate, and calibrate

1. Introduction

The Compressor Research Facility (CRF) Computer Support and Maintenance 5-year contract began in December 1991 and continued through August 1996. Twenty delivery orders were issued during the life of this contract to provide test monitoring and functional area support in the CRF. A final report was generated for each of these delivery orders providing details of all work performed for each task. These final reports are included as appendices.

2. Historical Information

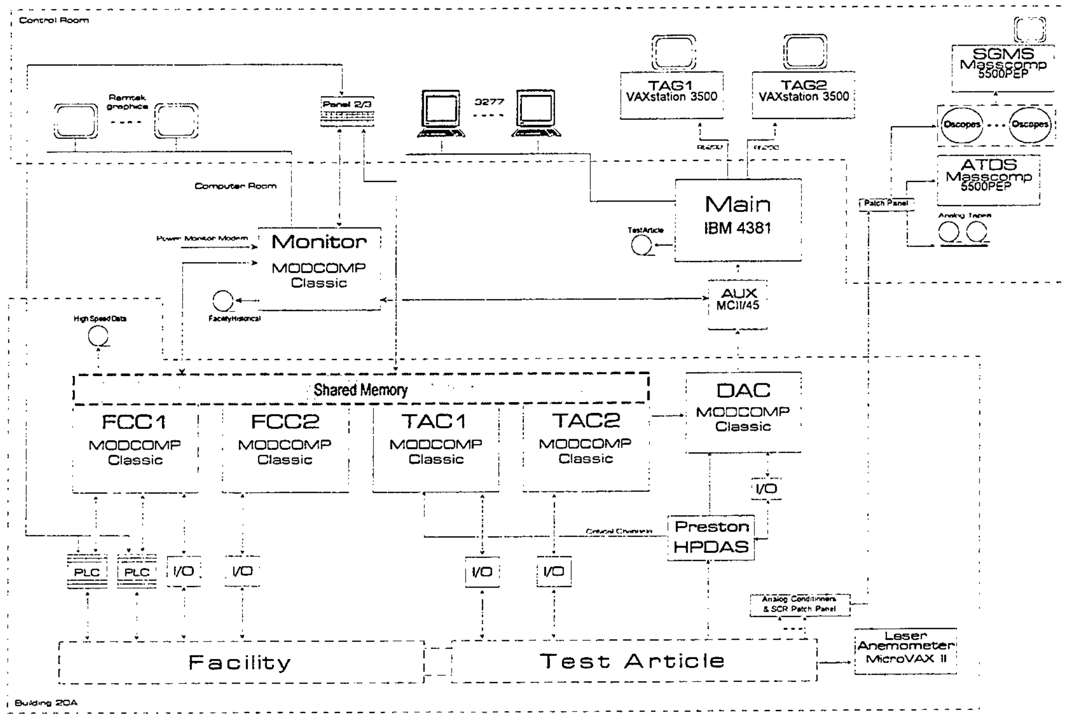
In 1991 the CRF computer network was comprised of 13 computers which performed online facility/test article control, data acquisition, data reduction, data analysis, and post-processing. Multiple hardware platforms and operating systems were being used. (See the table below.)

1991 Computer Network

Computer Hardware	Name	Op System	Communications
1 IBM 4381 ~12 3277 Terminals	Main	MVS/SP	Comten
2 VAXstation 3500s	TAG1 & TAG2	ULTRIX (UNIX)	RS-232
6 Modcomp Classics 2 Ramteks w/8 display units	DAC FCC1 & FCC2 Monitor TAC1 & TAC2	MAX IV	I/O Equipment Modcomp to Modcomp PLCs Power Monitoring Modem Shared Memory
1 Modcomp II	AUX	MAX III	Modcomp to IBM
2 Masscomp 5500s	SGMS & ATDS	RTU (UNIX)	Standalone
1 MicroVAX II	LTA	VMS	

See the Historical CRF Computer Configuration Control and Data Flow diagram for the computer network layout.

Historical CRF Computer Configuration – Control and Data Flow



2.1 Control and Data Acquisition Subsystems

The CRF computer network was comprised of two subsystems: Control and Data Acquisition. The Control computer subsystem included four Modcomp Classics for facility (FCC1 and FCC2) and test article control (TAC1 and TAC2). The Control computers communicated with each other via shared memory and with test article and facility devices through Modcomp I/O equipment and PLCs. The Data Acquisition subsystem included a Modcomp Classic (DAC), a Modcomp II (AUX), and an IBM 4381 (Main) to perform data acquisition, reduction, storage, and analysis. Another Modcomp Classic (Monitor) provided the operator interface to both the Control and Data Acquisition subsystems.

2.2 TAG1 and TAG2

Two VAXstation 3500s (TAG1 and TAG2) provided Test Article Graphics.

2.3 LTA

A MicroVAX II (Laser Transit Anemometer, LTA) was used to collect, process, and display Laser Anemometry data.

2.4 ATDS and SGMS

Two Masscomp 5500s (ATDS and SGMS) were used for analog tape digitizing and strain gage monitoring.

- The Analog Tape Digitizing System (ATDS) was used to analyze post-test digital data recorded on the facility's Analog Recording System. Up to 32 channels of analog data could be digitized at a maximum aggregate digitizing rate of 400,000 hertz. Various digital filtering and data correlation routines were available for data analysis. This system was also capable of generating a digital tape for further processing on other computers.
- The Strain Gage Monitoring System (SGMS) was used to monitor strain gage data for 108 oscilloscopes on the Aeromechanics Station during real-time or playback sessions. Up to four scopes at a time could be viewed on the graphics monitor. All 108 oscilloscopes could be monitored through corresponding alarms displayed on the Aeromechanics Station.

2.5 PCs

PCs were used throughout the CRF for data processing and inventory database maintenance.

2.6 Communications

Computer communications was simple, consisting of memory shared by the Control computers, Modcomp-to-Modcomp and Modcomp-to-IBM proprietary links, and RS-232 serial links. Communications outside the CRF was accomplished through an RS-232 terminal server which was disconnected during classified processing.

2.7 Computer Replacement and Enhancement Study

In 1989 Battelle performed a computer replacement and enhancement study to determine an information system solution to meet future CRF requirements since:

- Computer systems were old.
- Maintenance and leasing costs were high.
- Replacement parts were becoming more difficult to obtain.
- Future expansion capabilities were extremely limited.
- AF security requirements were becoming more stringent and attaining them with the current systems was no longer feasible.

Goals for an upgrade plan included:

- Standardizing hardware and software components.
- Migrating the data acquisition functions to a new centralized computer system/network.
- Determining a hardware vendor that could meet all the CRF's current and anticipated needs.
- Improving online data acquisition speed to handle approximately 200 additional instrumentation channels in the High-Performance Data Acquisition System (HPDAS) while not reducing the processing time.
- Reducing by at least 50% the time required to post-process test article data.
- Consolidating the computer graphics used for facility, online, and post-processing data displays (three different systems and graphics packages were used).
- Reducing the time required to classify and declassify the system thereby increasing the actual time available for computer system use.
- Providing a more reliable computer system for CRF testing to prevent down-time due to computer-related functions and provide simultaneous operation of real-time data acquisition and test data post-processing.
- Reducing the number of computer systems and operating environments in the CRF network.
- Replacing the various types of data display terminals used for online data monitoring with a standard terminal type able to display more than one window at a time.
- Improving online data analysis capability for all system users during CRF testing so that alphanumeric as well as graphics displays are available.
- Installing a more flexible system capable of future expansion if the demand for increased capability for CRF testing occurs.

2.8 Study Results and Computer Plan Implementation

DEC provided the best overall system solution to meet CRF requirements based on the results of the study. A computer upgrade plan was implemented and initiated with the purchase of a DEC VAX 6000 (V6) running the VMS operating system, Xterminals, and removable disks and tapes.

- The V6 was purchased on DEC's recommendation based on the results of the CRF benchmarks used in the study.
- Xterminals were selected as they are capable of supporting a wide range of applications and allow users to simultaneously access multiple host computers and displays.
- Removable disks and tapes cartridges were selected to meet security requirements and add flexibility when running various test programs.

Graphics standardization was also begun with the installation of the DataViews package. These changes implemented support for the VAX VMS operating system, eliminated the ULTRIX operating system and GKS (the DEC graphics package), and moved the facility closer towards attaining Air Force security requirements.

Arrangements were made through the WPAFB Network Management Center to have a router connection to the base-wide network installed in Building 71B and to have the CRF administer its own local area network (LAN). The new LAN was installed and computers, PCs, Xterminals, and peripherals were networked as appropriate.

The next phase of the upgrade plan was to migrate CRF data acquisition with Test Article Graphics. Originally, an additional CPU was to be purchased for the V6 to increase its capabilities. Technological advancements in the industry, however, made acquisition of the faster and less expensive VAXstation 4000-90 (VS4) a better option to perform facility data processing functions. The VS4 was purchased and all CRF data manipulation and display capabilities were redesigned and migrated to this system.

As a result of this migration, VS4 directly read Preston HPDAS data and the Main (IBM 4381), Modcomp-to-IBM link, Comten, V6, DAC (Modcomp Classic), AUX (Modcomp Classic), Ramteks, and 3277 terminals were removed from the network. The Event Logger, Trending, Power Monitoring, and Facility Graphics Monitor functions were migrated to VS4 thus eliminating the customized graphics and display hardware and software. Conrac displays were migrated to the Xterminals thus providing users with the ability to display any four screens simultaneously. These screens could include Facility Graphics, Test Article Graphics, Compressor Data Alphanumeric Displays, Playback, etc. Migrating the data manipulation and display capabilities to VS4 integrated all the graphics to a single, central computer system.

A VAXstation 3500 was then configured as the Post-Processing VAX (PPX). This standalone system could be used to perform classified/unclassified data post-processing or to test new system upgrades. It was the only system with a 6250 tape drive that could be used to read high-speed data tapes.

The MicroVAX II (LTA) was replaced with a VAXstation 3500 (Laser Anemometer Velocimeter, LAV). LTA adequately acquired the flow measurement; however, acquisition was slow due to excessive computing requirements.

Motorola NES data encryption equipment was added to the network to allow online communications with test article vendors. The encryption platforms provided the CRF with the capability to present "real time" displays and data directly to a customer's site. Data can be submitted directly to the customer's database. This capability allows customer personnel to participate in a test without traveling to the CRF and results in the saving of significant customer man hours.

A standalone system to continue software development and perform post-processing/data analysis even during test times was then acquired. This Development box (DVL, a DEC 3000-600S) was also used to run modeling software.

The Analog Data Analysis (ADA) system was upgraded from a Masscomp 5500 to a Masscomp 6450 to increase digitizing capabilities.

3. Current Computer Network

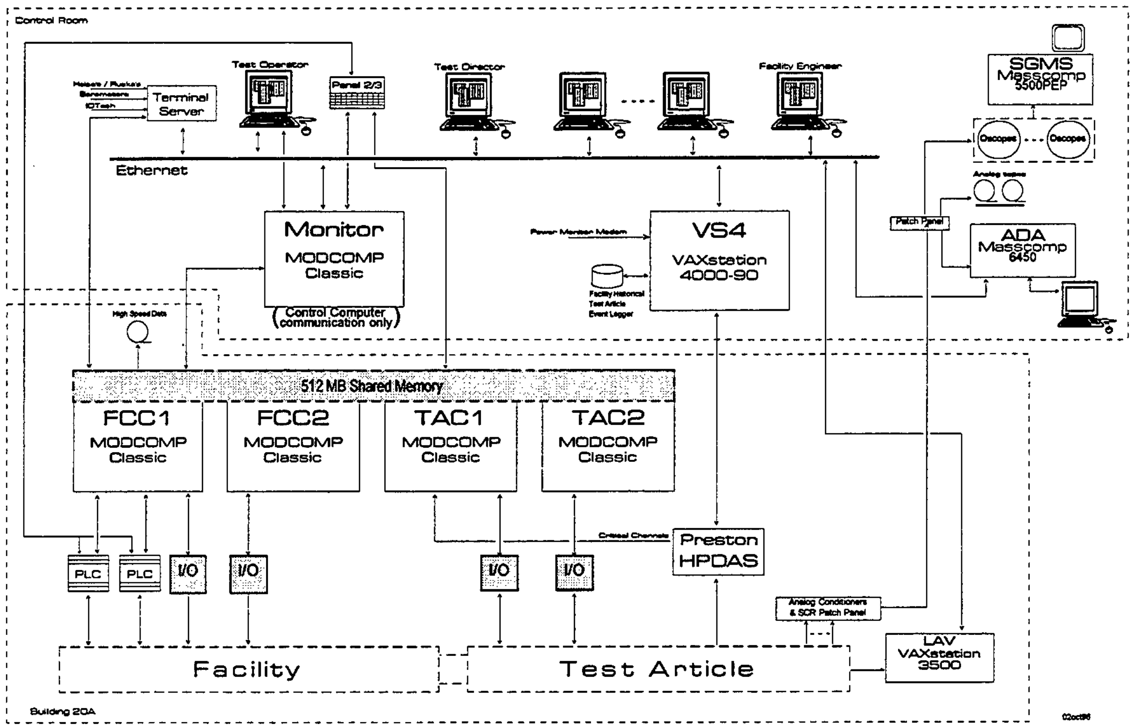
Today, the number of computers required for testing has been reduced and data processing and analysis capabilities have expanded exponentially. Major strides have been made towards achieving the goals of standardizing hardware, software, and communications; increasing capabilities; and removing custom components. (See the table below. Removed items have been crossed out.)

1996 Computer Network

Computer Hardware	Name	Op System	Communications
~~1 IBM 4381~~ ~~— 12 3277 Terminals~~	~~Main~~	~~MVS/SP~~	~~Comten~~
~~1 VAX 6000~~	~~V6~~	~~VMS~~	~~Ethernet~~
1 VAXstation 4000 (New)	VS4	VMS	Ethernet
1 DEC 3000-600S (New)	DVL	VMS	Ethernet
2 VAXstation 3500s	~~TAG1 & TAG2~~ LAV & PPX	~~UNIX~~ VMS	~~RS 232~~ Ethernet
~~6 Modcomp Classics~~ 5 Modcomp Classics ~~— 2 Ramteks~~ ~~— w/8 display units~~	~~DAC~~ FCC1 & FCC2 Monitor TAC1 & TAC2	MAX IV	I/O Equipment Modcomp to Modcomp PLCs Power Monitoring Modem Shared Memory
~~1 Modcomp II~~	~~AUX~~	~~MAX III~~	~~Modcomp to IBM~~
~~2 Masscomp 5500s~~ 1 Masscomp 5500	~~ADA~~ SGMS	~~UNIX~~ UNIX	~~Standalone~~ Standalone
1 Masscomp 6450 (New)	ADA	UNIX	Standalone
~~1 MicroVAX II~~	~~LTA~~	~~VMS~~	
32 Xterminals (New)			

See the Current CRF Online Computers Control and Data Flow diagram for the computer network layout.

Current CRF Online Computers – Control and Data Flow



3.1 VS4

VS4 is the heart of the data acquisition system. It accepts instructions from the Test Operator, controls the High Performance Data Acquisition System (HPDAS), and acquires, processes, stores and displays all non-control digital data in near real time. Eight hundred forty-eight digital test article data channels are acquired through the HPDAS. A test article database provides necessary test article and facility information to allow calculation and display of individual measurements, statistical calculations, measurement corrections, and performance calculations. Facility and test article related digital data is acquired from the Control computers. Enough data is processed in real time to allow Xterminals to display updating test article and facility display information in near real time.

3.2 FCC1, FCC2, TAC1, and TAC2

Modcomp Control computers (FCC1, FCC2, TAC1, and TAC2) are used for online facility and test article control as well as operator interface. The Control computers and programmable logic controllers (PLCs) control facility mechanical and electrical systems and test article variable geometry. They also monitor facility health parameters, initiate appropriate emergency actions when required, and transmit facility status and data for display and storage. In offline mode the Modcomps are used for valve calibration and tuning. The Monitor computer relays Facility Operator commands from the Control

Room to the Control computers and to VS4.

3.3 LAV

The Laser Anemometer Velocimeter (LAV) is dedicated to the process of acquiring laser flow measurement data from the facility's two laser anemometers. It acquires test article data from VS4 through the network. When the test involves classified data, LAV communicates with VS4 through an NES link.

3.4 ADA and SGMS

Two Masscomp computers are used for Analog Data Analysis (ADA) and the Strain Gage Monitoring System (SGMS). ADA (a Masscomp 6450) was previously known as the Analog Tape Digitizing System (ATDS). (See ATDS and SGMS in the Historical Information section.)

3.5 DVL

The DVL, a DEC 3000-600S, continues to be used as a standalone system to develop software and perform data analysis.

3.6 PCs

The PCs used today evolved from basically un-networked 286/386 DOS systems to the current networked 486/Pentium Windows 95 systems. CRF PCs have evolved from glorified typewriters to "mini power stations" which are used to:

- Design complicated graphics.
- Access the World Wide Web.
- Access government forms from POMIS.
- Order supplies online.
- Download or send information.
- Perform project scheduling.
- Manipulate databases.
- Incorporate graphics and text into a publishable document.

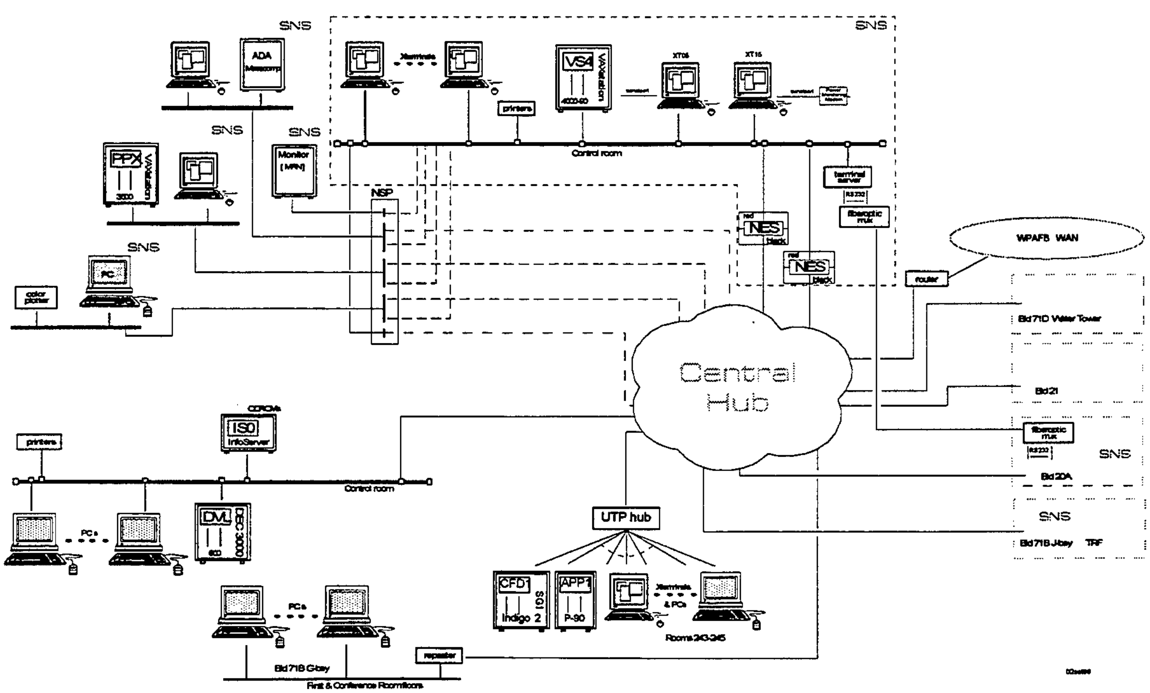
Approximately 50 PC systems have been configured; one of these also performs standalone classified data processing. In addition, a CRF NT server was configured to manage PC network applications, electronic mail, and internet addresses. Xterminals are also able to access PC applications on the network through the newly established WinDD service.

3.7 Computer Network

As computers, user needs, and security requirements evolved, the network evolved to accommodate these changes. The network includes six general areas in five buildings (71B, 71D, 20, 20A, and 21). Each of these areas is linked via fiber optic cable to a central hub. Redundancy and endurance were built into each link to reduce the chance of failure as well as allow bypasses and repairs to be made in a timely fashion. All computer systems, Xterminals, printers, and plotters have been connected to the network. A series of fiber optic links have been used to link critical instrumentation systems to the CRF Online computer network.

"Normal" networking requirements for global connectivity are supported while providing multiple "secure" LAN segments for classified or proprietary processing. Secure network segments (SNSes) provide isolation for a group of devices and a simple effective means of turning that isolation off or on. When necessary, these SNSes can be to connected to each other while isolated through a direct connection or by using approved encryption platforms. See the TRC LAN / Computing Systems Logical Configuration for Building 71B G-Bay.

TRC LAN / Computing Systems Logical Configuration for Building 71B G-Bay



3.8 Security

The primary role of security is to create an environment where the vulnerabilities of the network and systems are minimized and to ease the recovery from incidents. This is accomplished through instructions, procedures, training, and documentation.

All systems and networks must meet US Air Force and DOD regulations and guidelines. A Risk Analysis for each computer system and a Security Plan describing all system details and the methods used to protect against all identifiable risks is maintained.

Security in the facility is complicated due to the number of systems and their multiple locations as well as the necessity of switching security classification levels using the same system hardware. The addition of the network segment for printers and I/O devices as well as access to other similarly classified systems adds to the complexity.

The CRF has taken a proactive approach to security. System procedures were created or modified to check for appropriate classification levels on all removable media within the system as well as all known systems that may be reachable via the network. Fiber optic cable was used for all lengthy links to increase reliability and ensure upgradability; this eliminated TEMPEST and interference considerations almost completely. Methods were developed to allow secure network segments to be isolated for classified processing or connected for global communications. Various systems can be linked or unlinked through the Network Security Panel to ensure system isolation and protection of classified data. For example, the PC or PPX can be unlinked at the Network Security Panel from the rest of the network and then run in standalone classified mode. Remaining systems can continue to run in unclassified mode. When classified segments must communicate with each other and cannot be directly connected, approved network encryption system platforms are used to pass encrypted data across the open network. Daily security monitoring of the VMS systems was automated.

3.9 VS4 Functions

The VS4 is the hub of the information system. Some of the VS4 functions that were greatly enhanced are discussed in the following sections.

3.9.1 Test Article Data Acquisition

All test article data is tagged with a reading number. A Test Article Data Directory is maintained to allow users to access data taken during this test. Reading numbers change when the type of test article data being acquired changes. There are six types of test article data: monitor, static, channel check, pressure calibration, ZAD, and Kulite.

- Monitor data is acquired a scan at a time for an unlimited amount of time and is the most common mode of data acquisition. Data can be taken a single scan per second up to 10 scans a second. Every two or three seconds, a scan of monitor data is sent through the reduction software for conversion into engineering units which are then made available to the alphanumeric and graphics tasks for display. Monitor data taken at the default once-a-second rate is kept on disk for two run days (the day it is taken and the following test day). The Test Article Data Directory is automatically updated with the file status. Monitor data with acquisition rates greater than once a second are generally stored on disk for the length of the test for later playback and analysis. This data normally indicates some particular interest.
- Static data is 30 scans of data taken as quickly as it can be acquired by the analog-to-digital conversion gear. When a static data point has been acquired, there are 30 values for each of the measured headers. For each header, the 30 scans are averaged together and any data points which are too far from the standard deviation are discarded. These averaged values are then converted into engineering units. All static data types automatically terminate after 30 scans of data have been collected; each new static has its own reading number. During a test, all static data points are kept on disk for the entire length of the test to make data playback and analysis easier and quicker.
- Channel check data consists of two static data points: one taken with all the amplifiers in the data acquisition system set to 0 volts and the second static taken at 5 volts. Channel check data is used to convert counts into milivolts for all measurement channels in the system. Each set of coefficients (slope and offset) is unique for each channel and is stored in the database for later use.
- Pressure calibration (PCAL) data is a set of 5 or more static data points where a different known pressure is placed on the pressure transducers for each point. This type of data is used to convert milivolts into pressures on each pressure channel. The coefficients are different for each pressure channel and are stored in the database for future use.
- ZAD (ZOC and Druck) data points are used to test the integrity of the pressure system. A ZAD data point is a single static point taken with a known pressure applied to all pressure transducers.

Channels which read too far from the applied pressure are automatically deleted; testing will be delayed if too many channels are deleted. During a ZAD, degrees of freedom, bias errors and precision errors for each pressure channel, and a bias error for each pressure controller are calculated and stored to determine uncertainty for each measured and statistical header.

- Kulite static data is taken when a calibration procedure is performed on Kulite transducers.

3.9.2 Test Article and Facility Data Display

Software running on the CRF's computer systems allows users to view test article or facility data in both graphical and alphanumeric formats. Test article data includes temperatures and pressures within the test article, mass flow, pressure ratio, and efficiency. Facility data includes oil pressures and flow rates, motor speeds, vibrations and temperatures of critical bearings. All data is displayable on Xterminals in near real-time. Up to four screens of information can be displayed simultaneously on each Xterminal.

The online software is divided into two sections (Test Article Data System and Facility Data System) and includes help information. Help information is available for almost every feature the software presents to the user. It is available on a new user level, an advanced user level, and a software engineer level.

3.9.3 Test Article Data System

The Test Article Data System provides the capabilities to generate Test Article Data Alphanumeric Displays and Graphics, run playback sessions, access the data directory, and use the standard format files.

- Test Article Data Alphanumeric Displays presents test article data headers according to the stages on the test article or type of data presented. These are presented in alphabetical order (80 headers per screen), in a deleted header listing, or in a header out-of-limits list.
- Test Article Graphics presents test article data in a graphical format using pre-defined test-specific plot types. There are approximately 30 to 40 predefined graphs defined for each test. These plots can include pressure ratio versus mass flow, efficiency versus mass flow, X versus Y plots, strip charts, bar graphs, and so forth.
- Test Article Playback reads raw counts data stored during data acquisition and reprocesses the data. Either one or two playback sessions can be started and can run concurrently with an online test for comparison purposes. This option is also used to send data to a customer's site or to a standard format file as well as to quickly generate multiple data graphics.

- The Test Article Data Directory presents a listing of all data (monitor, static, PCAL, ZAD, Channel Check, and Kulites) that has been acquired during the test.
- Standard Format File Processing:

  Standard format files provide a fast method of analyzing data since the data has already been processed by the data reduction software. A preliminary file containing the results of each static point (but not monitor data) is created online during the test. Monitor data is not included to conserve disk space. At the end of the test, a final standard format file is generated which contains any changes to the performance constants and delete codes indicated by the Test Director as well as all ZAD points, static points obtained above zero speed, and any monitor data of particular interest. Copies of this file are made and stored for future analysis. The Standard Format File Processing option uses standard format file(s) to:

  - Generate X versus Y plots of multiple sets of data with up to nine headers.
  - Generate a report with values of up to nine headers.
  - Generate a report listing all header names in the database when a particular reading number was acquired.
  - Produce a report listing all the reading numbers on the standard format file.
  - Submit data on the standard format tape through the distortion analysis preprocessor to obtain an output file which can be processed by the distortion analysis software.
  - Send data on the standard format tape through the PERCH analysis preprocessor to obtain an output file which can be processed by the PERCH analysis software.

3.9.4 Facility Data System

The Facility Data System provides the capabilities to display Facility Graphics, perform plotting, and run Facility Playback sessions.

- Facility Graphics displays schematics of various CRF subsystems such as Drive Lube Oil and Electrical Drive Systems. These schematics contain header names and temperatures, pressures, flow rates, voltages, vibrations, and other measurements within the subsystem. Plots such as the Stator Vane / Stage Bleed Control screen are also displayed which show the positions of the variable geometry devices within the test article versus speed. A Power Monitoring screen displays the WPAFB power goal for the month, current peak usage to date, current electrical usage, and current CRF electrical usage. Since the WPAFB laboratory exceeding the established power goal for the month is penalized, this screen is used to closely monitor CRF electrical use and plan test runs accordingly to minimize power costs.

- Facility Graphics Plotting uses an X versus Y format to graph headers in the facility database versus time or another header. Specified headers can be indicated by name, facility database index, index plus bit position, or PLC number and octal address to provide additional versatility to the user. Current online or stored data can be used for plotting.
- Facility Playback post processes any facility data file on disk. Each facility data file represents a single test day and normally the current and previous three test days are on the disk. Older files can be restored from tape. Either one or two sessions can be started and can run concurrently with Facility Graphics to display processed data on Facility Graphics screens.

3.9.5 Health Monitoring System

The CRF software has the capability of designating up to 80 facility headers as critical channels. These 80 critical channels are read both as test article and facility data channels. Limits can be set for the channels which define high and low warning and alarm thresholds. These thresholds can be indexed to a certain speed. When an alarm threshold is exceeded (either high or low), one of 10 test termination actions can be activated by the facility computers. These actions range in severity from taking no action to tripping the facility drive system circuit breakers.

3.9.6 Event Logging

Information about all significant facility events occurring during a test is displayed and then a short description of the event and the time it occurred is stored on disk. The Event Log is used to track the exact series of events leading to a facility problem and is often used in conjunction with Facility Playback.

3.9.7 Test Article Database

The Test Article Database is used to configure the CRF computer systems for an individual test program. Inputs to the database include header definitions, data acquisition and processing formats, maps, calibration data and coefficients, test article peculiar parameters, limit checking, and signal patching.

3.9.8 Test Article Data System Reports

Various reports can be generated about the data system:

- Amplifier Configuration lists how all the Preston amplifiers are configured, where they are patched, the value the gain is set, and so forth.
- Thermocouple Connection reports how all the thermocouples are hooked up, the type they are, where they are patched, what amplifiers are used, etc.
- Pressure Connection reports how all the pressure channels are hooked up, what pressure controller is used, where they are patched, etc.
- Full Measurement System indicates the measurement channel types (pressure, temperature, vibration, load cell, etc.), how they are patched, and so forth.
- Unassigned Patching lists all open channels that can be used for new measurement requirements.
- Trouble Shooting reports all channels that were deleted because of a problem, the nature of the problem, and resolution priority.
- Patching Schedule describes the patch panel and where everything is patched.

3.10 Control Computer Functions

See the Historical CRF Computer Configuration Control and Data Flow diagram in the Historical Information section for a visual overview of the Control computer and PLC interaction.

Automatic control of the CRF variable speed drive system, test article, and various facility support systems is performed by the Modcomp Control computers and PLCs. The Facility Control Computer 2 (FCC2) performs closed loop control of the test article speed. Both Test Article Control Computers (TAC1 and TAC2) perform closed loop control of the test article. Facility support systems are primarily controlled by the PLCs. Facility Control Computer 1 (FCC1) coordinates all these systems.

A high-speed serial communications link connects FCC1 (Building 20A, Signal Conditioning Room) to the Monitor computer (CRF Control Room). The Monitor is the man-to-facility interface in the CRF control system. The MON/FCC1 link transmits operational commands from the Monitor to the Control computers. Shared memory interconnects the Control computers so that data can be easily communicated between them. The PLCs are connected to FCC1 with RS-232 serial communications links through which FCC1 may send or receive data to and from the two PLCs, thus linking the Control Room to the PLCs.

Various temperature, pressure, vibration, and electrical power sensors located throughout the facility and connected directly to the FCC1 provide FCC1 with facility monitoring data.

FCC1 is also responsible for:

- Monitoring other parameters that are actually read by the other Control computers and placed in shared memory. Out-of-limits conditions in this data are determined by FCC1 and automatic action to protect the facility and test article can be initiated in response to severe out-of-limits conditions on critical items.
- Transmitting once per second all facility data acquired by the Control computers to the Monitor. This information is relayed to VS4 so that facility information is available to test operations personnel.
- Sending status messages to VS4 via the Monitor when major facility events occur so that these event can be logged with the Event Logger.
- Supervising the operation of TAC1, FCC2, TAC2, and the PLCs with flags and parameters communicated through shared memory or the RS-232 links.

TAC1 provides automatic control of the CRF inlet valves, the test article discharge valve, and test article variable geometry items such as stator vanes and stage bleeds. Secondary functions include defining certain test article parameters, acquiring and maintaining calibration data for test article control system sensors, and providing local control functions for maintenance of test article and facility control devices.

FCC2 controls the CRF variable speed drive in a 10 msec control loop, acquires facility data, and detects certain facility faults. FCC2 software contains 9 of the 37 microsequences required to start the CRF. These microsequences control various phases of startup and shutdown for the 12,400 HP motor, the DC loop, the frequency converter, and the main drive motors. In addition there are software modules which generate speed setpoints and provide control for the variable speed drive. During normal operation, FCC1 generates setpoints to provide an interface between the speed control software and the test segment, speed trim, idle/minimum speed, and microsequence software. While the facility is operational, FCC2 performs the speed control functions during testing. FCC2 performs three types of data acquisition:

- Facility drive system electrical and temperature data is acquired for limit checking (performed by FCC1) and displayed and archived by VS4.
- Drive system control feedback parameters are acquired for FCC2 control purposes and displayed and archived by VS4.
- Instrument status for the 30 MVA transformer is acquired for use by FCC1 and the PLCs.

TAC2 performs a 40 msec closed loop control of the test article and operates under the supervision of TAC1 through flags and parameters communicated through shared memory.

4. Conclusions and Recommendations

Wright Laboratory plans to unify the functions of the CRF, TRF, CARL, and TEFF facilities under one umbrella: the Turbine Engine Research Center. To support this effort, computers and networks throughout these facilities are being consolidated. Plans include:

- Upgrading the CRF's VS4 to an Alpha system and replacing the LAV VAXstation with the displaced VS4 thus improving the capabilities of both systems.
- Implementing secure communications between the CRF buildings by installing a pressurized pipe through which the links can be run between the buildings.
- Continuing to research the possibility of upgrading the operating systems for the CRF Silicon Graphics computer and the TRF SUN.
- Enhancing aeromechanics capabilities by adding a system which will acquire and analyze light probe data as well as take over and expand the Strain Gage and Kulite data monitoring and analysis capabilities.

These plans, as well as others that are being developed, will be implemented as time, funds, technology, and manpower become available. It is the vision and implementation of plans such as these that help ensure that Wright Laboratory remains on the leading edge of technology today as well as tomorrow.

Appendix A

Delivery Order No. 1

Functional Manager / System Manager

Functional Manager / System Manager

Functional Manager / System Manager

Modcomp

All Modcomp spare components were inventoried and stocked. In addition, a surplused Modcomp 3285 system was acquired from the Fuels and Lubricants branch for use as CRF spares. To support Modcomp Ethernet communications, a Modcomp Routing Node (MRN) was purchased and installed so that facility data can be transmitted to the VAX. Software was written to transfer files from the Modcomp to a VAX. Although the throughput requirement was only 10 KB/sec, the unit benchmarked at 33 KB/sec.

Day-to-day system management tasks included preventative maintenance, documentation updates, and problem resolution.

Masscomp Analog Tape Digitizing System (ATDS)

To support the demand for additional strain gage and stall data processing, an ATDS upgrade system was purchased. This system has dual 68030 CPUs and floating point processors, an 80 MFlop state-of-the-art array processor, a 32-channel 2 MHz A/D system, 19-inch color graphics terminal, 1 GB of disk space, and a cartridge tape drive. The new computer system arrived in December 1992 and the hardware was configured. Operating system, FORTRAN, C, and Creare software was installed and a system backup was made to archive the system as it was delivered. A backup script was created and a backup tape rotation system was established.

Precursor Stall Detection

Software was developed to manage and process precursor stall data on the VAX.

Precursor stall identification software was developed to filter the data by IIR or FIR digital filters to remove frequencies not in the range of interest, perform irregularly spaced discrete spatial Fourier transforms to produce a time-varying mode which is to be modeled, apply the parameter estimation algorithms (recursive least squares, recursive extended least squares, and recursive maximum likelihood), and perform frequency domain identification. (Nine common AR and ARMA models were implemented.)

Facility Modification Requests (FMRs)

FMR #109 modified the alarm displays to reflect the correct alarm conditions and affected 33 Facility Graphics displays.

PC'S

The Alpha Four PC database product was purchased and installed to support cable, computer configuration, and tape library databases. The first database designed and implemented with this product is used to track CRF cables. It was based on a sequential file sort routine that had been developed on the Monitor. A database was also designed and implemented to track 4mm, TK50, and TK70 tapes.

Government PC hardware and software configurations are also being tracked and maintained. Miscellaneous software and hardware problems were resolved and a plan was generated to address the upgrade of all POT PCs to 486 systems.

A request was received to configure a classified PC running WordPerfect to support the generation of test reports. Available hardware and software were identified and a work order was written to have removable disk drives installed. Security paperwork is being compiled.

Pathworks

DEC Pathworks software was purchased and installed to support DEC-to-PC communications and PC-based network communications to a Modcomp computer. The Pathworks server software was installed on a VAXstation and a Pathworks client was established on a PC. This PC/VAX Pathworks connection will provide broader software access to conserve disk space, provide greater printer access, and simplify software maintenance. The ability to transfer files between the two platforms and to use WordPerfect on both types of systems will facilitate documentation and report development.

VAX Systems

A standardized VMS system was defined and implemented for all CRF VAX systems. All systems were converted to two disk systems, and unified startup procedures were developed and installed. Methods to control system software transfer between systems were developed and implemented. A basic user environment was established on the VMS systems. This entailed designing and implementing system and user procedures, directories, and logicals as well as establishing user accounts. Restricted identifiers were created and assigned to control the online application software.

Standardized procedures, based on the MAKE utility obtained from DECUS users' group, were installed to build CRF online software. Software was installed and tested, a makefile for the VMS application software was developed, and application subdirectories were reorganized. A procedure was written to compare all the application source files on different VAXes. Running it identified several discrepancies which are being corrected.

Procedures and command files were implemented to start the VAX online application software and user training was provided. Trouble-shooting procedures were documented and tested.

Several VAXstations were configured with directories and software control for online application software development. Information received at a DECUS symposium was used to rewrite the code that allows general users to shut down the VMS systems. This has simplified the operational procedure and greatly increased the security of system shutdown.

Research into a centralized operator station for all VMS systems was begun.

The NCD Xterminal configuration was finalized. Procedures were written to allow users to log on to any computer from any Xterminal. This allows the CRF online application to be started from a single Xterminal and open windows on several other Xterminals. Procedures were also written to allow a user to start an application and then walk away without compromising the security of his account.

Due to a concern that the indeterminate nature of Ethernet may cause unacceptable delays in real-time message transmission, a benchmark was designed. Results of the benchmark showed that the maximum time between messages was an acceptable time of only 2 seconds.

Three 4mm DAT tape subsystems were installed on the VAX 6000, VAXstation 4000, and PPX systems. Software was configured to use the 4mm DAT tape drives and the PPX 9-track tape drive from the other VAX systems, and backup procedures were written to utilize these new features. The 4mm system reduced the time required for the monthly backup from 6 to less than 2 hours. It also eliminated the need for repeated operator intervention.

Directories a$:[super] and a$:[tour] were created on the VAX 6000 and VAXstation 4000. [Super] contains a copy of the application software that is relatively stable and thoroughly tested. [Tour] contains only those files required for tours and replaces sensitive unclassified data with generic data. A JCL procedure was written to execute the [super] version of the software using the [tour] data files.

Refinements were made to the system backup routines. Routine system management duties included adding new accounts and correcting printer failures. The VMS 5.5-2HW upgrade was installed from CDROM. Various software (including NCD Xterminal download software, DataViews patches, and FORTRAN 5.9) was installed on all VAX systems. Several X window utilities from DECUS were installed, tested, and documented.

VAX 6000

The Winchester disk system was converted to a non-priority bus system based on Digital's decision not to support Winchester's priority system. The VAX 6000 now has 2.4 GB of unclassified disk online.

Print queues were stalling the system. Terminal server setup was reduced to a minimum on the printer ports and further research showed that there were problems with LAT print queues when VMS 5.4-3 was used with outdated terminal server software. Updated terminal server software was acquired and installed.

Intermittent hardware problems were experienced with the VAX 6000 4mm DAT tape drive. The drive, which was under warranty, was replaced by the manufacturer.

Several attempts were made to test the Logical Company fiber optic interface for the DRB32. DEC technical support was called after the system crashed. An examination of the device driver source code revealed that although simultaneous input and output is physically possible, it is not supported by the standard driver. Testing will continue when a solution is reached.

VAXstation 4000

The VAXstation 4000 system was configured. This included installing the 4000, Dataram memory, and a turbo channel adapter as well as connecting the Winchester removable disk chassis and 4mm DAT tape drive. The RD42 CDROM was temporarily connected to the system, and the VMS 5.5-2HW operating system, FORTRAN, C, DataViews, disk, 4mm, Xterminal, and terminal server download software was installed. Accounts were transferred from the VAX 6000. Several VAXstation booting problems were encountered and resolved. Persisting Winchester Systems disk problems were tracked to the firmware on the disks themselves. Winchester Systems is scheduled to update these disks.

The DCT-1000 interface was installed on the turbo channel, and diagnostics and basic testing were completed; however, this interface causes the system to crash under Stand-Alone Backup. A patch was obtained from DEC to resolve the problem.

The Ethernet adapter initially caused problems with the security checks performed during startup. Procedures were modified to correct these problems.

The X window management benchmarks showed that the VAXstation 4000 is up to 12 times faster than the VAX 6000. Disk I/O and low-level X window operations run at about the same speed on both systems. However, the VAXstation 4000 was able to support 90 Facility Graphics windows updating once every 2 seconds with the CPU only 6% busy. Response time to create the first window was 3.8 seconds; for the 90th window it was 5.1 seconds. (After the window is created, switching from one display to another is much faster.) For comparison, the VAX 6000 was 91% busy with 55 windows running, and response time for the 55th window was over 1 minute.

InfoServer

An InfoServer 100 was purchased to replace the magnetic load/update media. This will allow CDROM distribution which will save both time and money. A separate load device will no longer be required on each system.

The InfoServer 100 was mounted on top of the VAX 6000 peripherals cabinet. An RZ23 disk was connected to it, and a tap and transceiver for it were installed on the network. Initial testing has been performed.

PPX

The PPX VAXstation was relocated to better accommodate secret data processing, a 1.3GB disk was purchased for a data disk, and a 4mm DAT tape drive was installed on the system. Disk problems were encountered and remain to be resolved. Replacement components were acquired and installed, but the information on the disks was corrupted. Since the disks were not physically damaged, the problems seem to be related to configuration or controller errors. The large blocks of time required to reformat and rebuild the disks has hampered the solution to these problems. Work will continue as soon as higher priority items allow.

Networking

Network problems were experienced due to a malfunctioning Ethernet controller. DEC maintenance personnel were assisted in replacing the controller, and software modifications were made.

To facilitate the development of new software during CRF testing, the internal CRF LAN was divided into two segments to simultaneously allow online classified processing and unclassified software development.

Battelle is working with the ASD computer center to install a direct LAN connection from the CRF to the Area B fiber ring and fiber optic cables between buildings 71B and 20A. This will allow the DOIP broadband and cut-off switch to be removed in the secure CRF area which will simplify security and allow the unclassified portion of the CRF LAN to access the outside world during classified processing. It will also resolve administrative problems between the CRF and DOIP such as the issuance of network addresses and utilization of ASD computer center resources for problem solving. The fiber between the buildings (along with the fiber optic LAN repeaters) is the first step to extend the unclassified CRF LAN to the Signal Conditioning Room. Remaining work includes fabricating jumper cables to run from the communications closet to the actual devices, and receiving the router and network management/addressing information.

Local printer access was established over the LAN to print files from systems outside the CRF. This allows print files such as government forms which reside on the WL POMIS system to be printed in the CRF. A Lantronix terminal server with a parallel port was installed to speed up the printing process.

Twelve Xterminals were added to the network. Network printers, a VAXstation, and an Xterminal were centralized in the Computer Room to provide work tools for those manning a CRF test.

In the near future, the CRF will provide online test monitoring capabilities to Test Article vendors. Encryption devices and a connection to ASD's T1 link will be required to accomplish this task. Research is underway to evaluate encryption equipment requirements. General Electric is performing a similar study and it appears that Motorola has a product which may meet the CRF's requirements. Additional data will be acquired and a purchase decision will be made in the near future. Connection to ASD's T1 link is also being researched. Testing will be performed when the CRF LAN is restructured with router access to the Area B fiber ring.

Xterminals

Polaroid screens to reduce the glare on Xterminal screens were obtained for evaluation. Overall consensus was not favorable and the screens were returned.

Shelves were designed to allow an Xterminal to be mounted in a 19-inch rack. Six shelves were constructed by the government machine shop. Two were installed at the Aero and Drive stations. The other four were installed at the Test Operator's station.

Eight new NCD19C Xterminals were configured and an additional 4MB of memory was installed. These Xterminals will be connected to the network prior to the next test. A power supply failure was experienced in one of the original Xterminals and the warranted unit was repaired.

Color Plotter

A study to provide color plotting capabilities for the VAX systems was performed. Considerations included using the current Seiko RGB plotter, finding a color plotter that used the device drivers available with DataViews, or finding a new RGB plotter that would work. It was determined that the existing Seiko RGB plotter would not function with the bandwidth of the Xterminals and cannot be upgraded. Since the cost of an RGB device was high compared with those that function with a Postscript driver, the study focused on color plotters that would function with a Postscript driver. This would allow the plotter to be used by all CRF VAX systems and PCs. Upon conclusion of the study, a Tektronix Phaser II plotter was ordered.

Critical Channel Buzzer

A two-tone buzzer box has been constructed to replace the Monitor I/O warning buzzers on the VAX system. Initial testing has been performed; however, communications between VMS systems and the DIGITAL-232 are still unstable. Work will continue as time permits.

Security

Security guide documentation and classification/declassification software procedures for the VAX 6000, PPX, and Monitor were written and maintained. Operator and system user notes for general system startup as well as classified processing were written and operator/user training was provided.

Security plans were generated for LAV and the VAXstation 4000. Floor plans, system configurations, and operating procedures were also generated.

Software

All VAX FORTRAN software was examined to ensure each module contained an IMPLICIT NONE statement. This statement will cause a compilation error if a variable is not declared and help identify problems when wrong data types are used.

Subroutine X2X was sped up by the use of a block move. Subroutine errors in the "fill" logic were corrected.

Software was modified to simplify mapping to a global section. The new subroutine specifies the name of the section instead of its number. It also allows a section to be mapped as read-only to minimize the possibility that an error in one program will cause other programs to fail.

Documentation

Computer and system operator notes were written and revised.

VMS software documentation for the new Operations and Maintenance Manuals was begun. Draft copies of the user interface, software design decisions, and the master control program process were produced.

Computer and Control Room floor plans were updated to include Ethernet and fire detection systems.

Online documentation is being generated for end users and programmers. A series of graphic help screens were designed and implemented. These will help users understand how the user interfaces work with the terminal menu screens, facility information displays, and facility playback control.

User Interface

The user interface for NCD Xterminal users was implemented. Users were heavily involved in the initial design and will continue to be involved as more functions are migrated.

Event Logging

The Monitor Event Logging function was migrated to the VAX. Messages will now be displayed in an Xterminal window which allows the last 9,999 messages to be examined. These messages will be stored on the VAX disk and can be printed by a Facility Engineer at any time. In addition, messages were expanded and enhanced to print a message for every header that goes into alarm or warning, and software was added to clarify the reason for test termination.

Facility Graphics

Facility Database Generator modifications were made to create several new database file structures for Facility Graphics. The capability to read facility database input data and generate database files for online and post-processing use was added to the Database Generator. Header, units, index, type, and scale files were also added.

Detailed documentation was generated for each Monitor Facility Graphics display to support development and testing of Facility Graphics on the VAX system. It included a "map" of each display, related documentation describing the different conditions each channel may have, and the colors and text entries related to each channel condition.

Two tasks were written to incorporate Facility Graphics displays on the Xterminals. One reads facility historical data from the Control computers, processes this data, and then produces engineering units which can be displayed. The other task displays engineering units in alphanumeric and graphic formats. The Facility Information Display (FAIND) task was designed and implemented and all displays were generated using the DataViews graphics package.

Monitor software modifications were made to allow setting and resetting microsequence system ready bits in support of Facility Graphics, Alarm Checking, and Event Logging testing.

Alarm Checking

The new Alarm Checking function was implemented. Design considerations included identifying which headers need to be alarm-checked, coding each checked variable so that each is not checked prematurely, generating a new database file structure for each checked variable identified by the microsequence at which the checking is to begin, identifying which screens are active and are available to Alarm Checking, describing the "type" of each fault so that the action on the fault is correct, identifying duplicate alarm-checked headers which appear on more than one screen and allowing acknowledgments to affect these headers on all screens, calculating fault severity or acknowledgment and communicating the fault status to other modules, and answering questions about the present and developing system during the checkout and creation processes of the new system.

Test Operator's Control

The Test Operator's Xterminal Control function was designed, coded, and tested. This included a graphical user interface which allows the Test Operator to control the four Xterminals at the Test Operator's station.

Database Generation and Test Article Data Reduction

The general layout for the database input file was defined. Software was generated to read the input file and create several disk files for use by the online and post-processing software as database files. A header file, delete code file, units file, and an engineering units file were created.

Test Article Facility Database Generator modifications were designed and software development was begun on the Database Generator. Twenty-nine database files needed for data reduction can now be successfully generated. All IBM data reduction software was transferred to the VAX. Software interface routines were written for the data reduction software to allow data retrieval from the new database files. The reduction software, new database files, and data retrieval interface routines were successfully compiled and linked on the VAX.

Facility Data Playback

Software design for the Facility Data Playback Control function was completed. This function allows two playback sessions to run concurrently with the online data acquisition, processing, and display software. The Facility Database Generator was expanded to create the required database files to perform data playback during online data processing. Graphic screens were designed, developed, implemented, and tested. Numerous enhancements were made to Facility Graphics playback on the VAX.

Communications Between the IBM 4381 / Comten and VAX 6000

The IBM-to-VAX communications task was implemented. This task reads data from an RS-232 link connected to the IBM/Comten communications device.

Data Reduction

A baseline data reduction task was implemented. The final design will incorporate taking data from the Preston and producing engineering units on its own. Currently, it produces averages and normalized statistical data and converts degrees Fahrenheit to degrees Kelvin.

Standard Format File Creation

Standard format file creation is being implemented in two phases. In the first phase a standard format file will be created online from engineering units. In the second phase a standard format file will be created in a post-processing mode. Phase I is complete and Standard Format Tapes (SFTs) can be generated and plotted online. End users have been closely involved in the implementation of this task.

Data Storage

Benchmarks were executed using the 4mm DAT tape drives and facility historical data to determine how to store data. Since 12 hours of facility data can be copied in 7 minutes (plus 0-8 minutes of fast-forwarding time to find the end of the last file on the tape and 0-1 minutes to rewind), it was decided that all the facility data for an entire test would be stored on 2 tapes with each tape used on alternate days. The compression ratio for this kind of data permits eighteen 12-hour days of facility historical data on one tape. (An average day contains less than 12 hours of data.)

Software Control and Tracking

A software management tool was developed to compare application files. This tool compares module creation dates and performs a source code line-by-line comparison. It has been used to uncover several discrepancies in the DataViews binary view files. A utility subroutine was written to simplify the association of a DV-Draw DataViews variable with a FORTRAN program variable. Procedures were written to check out application modules or data files.

A notebook to log VAX problems and document events was established.

A command file was written to promote software from a user's directory into the master application directory. This command file puts the module into the proper subdirectory, compiles it, and links it with all appropriate software. In the case of the Database Generator module, the command file will promote the software into the proper subdirectory and create new database files.

Appendix B

Delivery Order No. 2

XTC66 Test Support

XTC66 Test Support

The work performed under this delivery order provided development, modification, and redesign efforts to support the XTC66 compressor test.

Computer Security

A security plan was generated to allow the VAX 6000 (V6) to process and display classified data. Floor layouts and operational procedures were also generated. Software programs were written to declassify CRTs and Xterminals.

Analog Tape Digitizing System (ATDS)

In support of the XTC66 test, the ATDS strain gage data acquisition and analysis software was enhanced and Campbell diagram and table generation were automated. Masscomp memory was upgraded and the following software enhancements were made.

- Due to the high RPM range of the XTC66 Test Article, the maximum samples acquired per sampling burst was doubled. This doubles the frequency resolution of FFTs performed on the samples.

- Campbell diagram generation was automated to allow users to generate diagrams overnight. Up to 104 Campbell diagrams and tables for up to 28 channels on an analog tape can be requested at a time.

- Software modifications were made to the database software to read the Campbell tables.

Hardware and software support was provided throughout the test to debug ATDS and tape deck patching problems.

User support and training were provided to configure the ATDS for stall data acquisition and IDARS processing and to monitor disk space and data archiving.

Software was written to process ATDS stall data on a VAXstation. To facilitate this processing, an irregularly spaced DFT and a digital filtering program were written. All software was tested on stall data provided by MIT. Digital filters were designed and applied to stall data.

System identification software was written to provide mathematical models of system stability just before stall. The model is a time varying difference equation in the form of an adaptive recursive least squares filter. The recursive least squares filter was implemented in complex form along with two variants: the recursive extended least squares and the recursive maximum likelihood. The recursive least squares algorithm is historically prone to divergence; therefore, several methods of "forgetting factor" calculation were included to help alleviate this problem. These methods have successfully detected instability in stall data from MIT and will be used on XTC66 data. This type of model has been used by researchers at MIT to successfully predict stall.

Trouble Logs

Detailed technical documentation was written for each trouble log and incorporated in CRF documentation.

Trouble Log #	Color Graphics Screens Affected
9207701	Drive Lube Oil (14 & 15)
9207702	Test Chamber (24)
9207703	Slip Ring (38), AUX Air (20)
9207704	Electrical Drive (27)
9208501	Drive Lube Oil (14 & 15), TALO Return (18), Test Chamber #1 (24), Electrical Drive (27), Annunciator
9208602	Drive Lube Oil (14)
9208603	Electrical Drive (26) - Remove RTDs
9210105	Electrical Drive (26)
9210102	Annunciator for TALO Return (18)
9210101	Annunciator High Speed Gearbox Vibrations (33)
9209701	SV/SB Control (13)
9209001	Electrical Drive (27)
9209211	Drive Lube Oil 1 (14)
9209207	Diesel Generator (09)
9209203	AUX Air (20)

Trouble Log # 9214701

FCC1 won't boot.

Problem Solution:

Disk diagnostics were run and the problem was tracked to the EAU board. The "bad" board was replaced and sent in for repair.

Trouble Log # 9213401

Critical channels "glitched" at min speed, causing 8 headers to go into alarm status.

Problem Solution:

The facility historical tape was reviewed and a data shift problem was identified. The signal from one channel was being replaced with the signal from another channel for intermittent and random pulses. A software module (HLTEST) was incorporated into the Wide Range/High Level Monitoring (WHM) software to help identify the problem. Four control cards were swapped between TAC1 HL1 and HL2 but no change occurred. When the voltage supplies were swapped, the problem followed. The bad voltage supply was then replaced and the channels were tested.

Trouble Log # 9212601

Add Event Logger confirmation from Monitor when WAIT button is pressed, prior to FCC acknowledging a WAIT taking effect.

Problem Solution:

Monitor software was modified to check the CAI for an interrupt in bit 4 of Expander 0, slot 3. When this occurs, the message "*WAIT BUTTON PRESSED*" will be written to the Event Logger.

Trouble Log # 9211403

E06-S-1 read about 2 RPM lower (-509) than the digital tachometer displayed at the operator's station (-507) during the process of trying to synchronize the drive motor with the output of the frequency converter.

Problem Solution:

E06-S-1 was recalibrated from the FCC2 Wide Range Analog Input Subsystem (WRAIS) to the computer. The slope changed from 3.52941 to 3.75765; the offset changed from 0.0 to -1.39033.

It was realized at the time that this slope and offset would seem to exaggerate the problem. This proved to be true. The channel was later calibrated from the pick-up into the computer. In this process the range was changed to obtain a more linear (and functional) fit.

Trouble Log # 9210104

ZAE-29 on the color graphics is reading twice the value at the drive station. The probe is a 200 mv/mil probe, not a 100 mv/mil probe. ZAE-29 is on the pedestal.

Problem Solution:

The scale factor for this channel was set at 0.002 rather than 0.001. The scale factor was changed on the Monitor and the Control computers.

Limit Check Database Modifications

Trouble Log # 9210103 Delete RTD-201 (DTA-438).
9209902 Change status from "ON" to "DIS" for ZAE-30, 51, 56, and 29.

Trouble Log # 9209212

S3 reads 280 at min speed while TA back calculation on screen 31 says 240.

Problem Solution:

S3 was recalibrated from the FCC1 WRAIS into the computer. This adjustment changed the slope from -2.4038 to -2.4425 and the offset from -12.019 to -6.8389. Voltage testing resulted in expected performance.

Under test conditions the calibration didn't have a large impact. The channel was then calibrated empirically to account for losses in the transmission from the pick-up to the computer. The channel now agrees with the back calculation. This empirical calibration was a back calculation taken from the expected and actual counts readings.

Trouble Log # 9209208

Single up and down speed control switches at the operator's panel did not work until after a double down was tried, "ARMED" indicator was on. This was during FC Stator Breaker sequence in preparation for drive motor synchronization.

Problem Solution:

This problem was attributed to operator error. Trimming up in speed (absolute) is actually a decrease arithmetically. In other words, an increase or single/double up will decrease the absolute speed since it may travel from -509.0 to -506.0. This is actually an increase. The maximum absolute value that trimming may have is -509.0 RPM. This avoids the zero-speed area at around 514 (absolute) RPM. The trim panel did not require a double down input prior to operation.

Trouble Log # 9130102

With real-time software up, the system occasionally hangs while taking static data.

Problem Solution:

All software links were tuned.

Trouble Log # 9213902

Problems exist trying to get Test Article Graphics to work. On the 5/15/92 run, only terminals 3 and 6 would come up. Those terminals were not able to receive data from the IBM. Terminals 4 and 5 did not come up at all. All trouble-shooting procedures were tried.

Problem Solution:

A lot of time was spent looking for a software problem because the system would work in an unclassified mode, but not in the classified mode. Link code was double checked, extra error checking software was added, and more detailed trouble-shooting procedures were written. However, the problem was eventually traced to a loose pin on the RS-232 cable which connects the Comten system to the V6 computer. Since this cable is disconnected and reconnected each time the system goes classified, sometimes the pin does not make good contact. This caused the problem to come and go in a seemingly random pattern.

Trouble Log # 9214901

Negative 30000 codes, which are not currently used, show up as blanks on the compressor alphanumeric displays (on the Xterminals).

Problem Solution:

Software modifications were made so that negative 30000 flags (which have no meaning) are displayed as numeric values instead of trying to retrieve a text string which has not been defined.

Trouble Log # 9214902

V6 compressor data alphanumeric display exhibited numbers in the wrong places when above zero speed.

Problem Solution:

Additional capabilities were added to the V6 software to allow data to be viewed as it comes across the link from the IBM and Comten. The capability to take a snapshot of the information in any of the count and engineering units global common page sections was also added. This will give users and programmers additional tools to debug problems such as the one described above. These new tools were used to trace the problem to task IBM2V6 which places the data from the IBM and Comten link into the count global common page section.

Trouble Log # 9002504

Modify servo control software to allow 16 positional stator vanes.

Problem Solution:

This task was accomplished in three phases:

(1) Global common sizes were changed in the Control computers.

(2) Global common sizes were changed in the Monitor.

(3) Positional stator vane feedbacks, setpoints, etc. were relocated within global common.

Extensive testing was done after each phase.

Trouble Log # 9210706

E-Trip apparently caused by sudden report of Test Article or drive motor speed increase immediately after indication of E-Stop. Test Article indication went from 17580 to 20180 RPM in one second.

Problem Solution:

This problem was a result of incorrect drive motor speed sensor calibration (which may need to be recalibrated whenever the rotation direction changes). Drive motor speed was recalibrated.

Trouble Log #9211901

The DAC/Monitor link consistently failed and had to be reset.

Problem Solution:

This was an intermittent hardware problem that the diagnostics either did not check for or were not run long enough to catch. MFSI "tuned" the link, but no improvement was observed. It is possible that sometimes the message receiver did not get an interrupt. Since there was no timeout in the handler, the link hung until the operator intervened. A bug in the NET program aggravated the problem by not cleaning up the data structures properly when this occurred (sometimes requiring a Monitor reboot). Several changes to NET were made. If a reply is not received within a sysgen-specified time, the link is terminated and a new message can be sent. The logic to automatically take a link offline after 16 errors was deleted. Receive buffers were enlarged to correct another intermittent hardware problem (buffer overflows).

Appendix C

Delivery Order No. 3

Enhanced Flow Compressor Test Support

Enhanced Flow Compressor Test

In support of the Enhanced Flow Compressor Test, Battelle provided development, modification, and redesign efforts to maintain the readiness and enhance the capabilities of the Compressor Research Facilities' (CRF) embedded computer and instrumentation subsystems. Problems were solved and system and application software development and enhancements were provided to meet test article peculiar requirements and contingencies that arose during the preparation and execution of the test program. All work was assigned via the CRF trouble log system and documentation was generated and incorporated into CRF and/or test documents as appropriate.

CRF Operations and Maintenance Manuals (security plans, system and operator notes, database and commons, and site logs) were reviewed and updated prior to the execution of the test.

Trouble Log #9224001

Campbell diagramming software requires modification to plot Campbell data against time or RPM axes, plot IDARS data against Campbell diagram data with individual scales for the alternate y-axis variables, and initiate data acquisition at a user-selected time code time.

Solution

Global commons were established to efficiently handle the growth in the number of variables passed between subroutines. Software was written to extract data from IDARS datasets and inform the user of the number of samples read as well as the maximum and minimum values.

Alternate y-axis data plotting routines were written to allow variables to be displayed in the same data window as Campbell diagram data. Graphical symbols (circles, squares, triangles, and hour-glasses) were used to identify the lines and the user was given the option to input alternate y-axis variable names, units, and ranges. Automatic positioning, scaling, and labeling of alternate y-axis data was implemented.

X-axis drawing and scaling routines were modified to allow the user to plot time or RPM data. Provisions were made to scale the time axis correctly if the user plays back the tape at a different speed than the alternate y-axis data.

Data acquisition software was modified to provide time code translator triggering of the Campbell data acquisition process to align time data. This required the use of an additional clock to correlate

Campbell data with IDARS data.

The data acquisition menu was modified to allow user-initiated or external triggering of data acquisition and to incorporate real-time processing.

Trouble Log #9214901

The V6 Compressor Data Alphanumeric Display puts numbers in the wrong spots when the test article speed is greater than zero.

Solution

Software was written on the VAX to display the data received from the IBM and to allow a user to view online counts and engineering unit global common page sections. This will facilitate debugging future problems with the link, data reduction, and data display software. This particular problem occurred because an improper format was used when decoding an E format character string.

Trouble Log #9213902

Recurring problems arise when bringing up test article graphics. Only a few of the terminals came up and they were unable to receive data from the IBM.

Solution

Additional error checking was added to the VAX software and troubleshooting procedures were expanded. This problem was traced to a bad transceiver which was replaced.

Trouble Log #9221101

Data link problems prevented the execution of Channel Checks and PCALs.

Solution

The DAC and AUX computers were able to send data to the IBM in Monitor mode; however, the software hung in static mode.

The Modcomp link hardware and IBM software were modified to resolve the problem. The characteristics of the hardware had changed slightly and a software delay is now required to allow the hardware to reset itself before the next read is issued.

Trouble Log #9231102

Facility E-Tripped 6 seconds after start of sequence 22. Cause of trip was loss of field relay 40-2. While in the sequence, exciter E4 was not commanded on.

Solution

The FCC sequence fault was set before microsequence number 22 started because the drive motor selection code was 0. A software change had been made in the PLCs; but, the corresponding change was not requested in the Control computers. Control computer software changes were made as required.

Trouble Log #9231103

Monitor program MON sometimes aborts with reason code "TMR" when coming up in normal mode.

Solution

The abort was caused by MON trying to connect a timer to task RMT before it had been activated. The timer connect logic was moved to resolve the problem.

Trouble Log #9225403 & #9225402

Long delays occur between the time the facility panel is armed and when the sequence is accessible. Also, delays occur when other control buttons are pressed on the Facility Operator's panel. Problem is related to FCC link-up trouble.

Facility color graphics periodically flashes alarm in computer status screen. Reason was seen as PLCs, FCCs, and TACs as "???" (state unknown), then quickly returned online without E-Tripping the facility.

Solution

The Monitor side of the FCC1-Monitor link was faulty which inhibited updates from FCC1. The link was repaired and replaced.

Trouble Log #9225401

Facility color graphics system will require a permanent TALO return display addition of the delta-P (Pressure) across the TALO air/oil separators. This will consist of a block which is green for normal, yellow for warning, and red for alarm.

The alarm fault will be an E-Stop action at 9 inches of water, the warning fault will occur at 11 inches of water. The device number is M12-PDSH-85, bit #'s 12004 (warning) and 12104 (alarm). Bit set (1) = OK, bit reset (0) = fault state.

Solution

Facility color graphics TALO Return and TALO Supply screens were modified as requested. The annunciator was updated, and the facility graphics and database documentation was updated.

Trouble Log #9223001

Facility color graphics SV/SB Control, SV/SB Channels, and Critical Channels screens were modified to add new SV/SB schedules and change y-axis names and positions.

Trouble Log #9220901

Latch-bits have been created in the PLCs to mark conditions that cause alarm faults. This has resulted in the movement of 6 bit-definitions that currently appear in the color graphics screens. The 50 new latch-bits should be integrated into the existing screens and used as alarm message generators for the Event Logger.

Solution

Facility graphics changes were made to the Filter House, Hydraulic, Drive Lube Oil, Test Article Lube Oil, Auxiliary Air, Drive Ventilation, Test Chamber, Electrical Drive, and Slip Ring screens. The Annunciator and Monitor initialization software also required modification.

Trouble Log #9226002

Base peak month-to-date power number changes without entry. This appeared to change after facility restart.

Solution

This is exactly what should happen; the number **should** be overwritten when a greater value than that which is stored is encountered. However, the **cause** of the overwrite was incorrect. Problems with the estimators caused unrealistically high values to be stored for some of the 30-second updates. To alleviate this problem two additional estimators were written – one backs up the original estimator and the other allows the Monitor operator to input an estimated background value when the modem has quit sending updates. In addition, the 30-minute time frame would not reset when the period broke exactly on the 1800/0000 second mark. When this failure to reset occurred, a new peak was set, recorded, and written to the historical file for the peak in the month. This problem has been corrected. The communications problem between estimations in programs PCL and PWR has also been corrected.

Trouble Log #9228006

On the Test Article Return screen, FE07 showed reverse polarity as well as flow changing too much and out of range of pump system.

Solution

The coefficients for slope and offset on the delta-P transducer had changed. These were adjusted and the reading is now correct.

Trouble Log #9228101

On facility color graphics hydraulic screen, remove valves ZSH-17 and ZSH-12 from display.

Solution

ZSH-12 and ZSH-17 were removed.

Trouble Log #9228102

Drive Lube Oil-3 screen - Modify VA2 to show OPEN and BYPASS conditions; fill with green.

Drive Lube Oil-1 screen - The vent symbol has 2 meanings, vent and return to tank; no matching point in tank.

Solution

Facility color graphics screen modifications were made as requested.

Trouble Log #9228103

On Drive Lube Oil-3 screen, PIC04 should be PDIC04.

On Auxiliary Air screen, ZSH80 when green should read CLOSED and show as a relief valve.

Solution

Facility color graphics screen modifications were made as requested.

Other Test Support

Online Facility Data Playback

Software was written to send facility data once a second from the Monitor to VAX and save it on disk. This gave the CRF the new capability of plotting any facility header online which allows a problem to be identified without restarting the facility or shutting down the Monitor to run playback.

Saving facility data on disk instead of tape also allows playback to run in parallel with real-time control. Software was written with a graphical interface to allow the user to go to any given time within seconds and to go forward or backward at any rate.

Procedures were written to allocate, backup, restore, and delete VAX facility historical data files.

Test Article Microsequence Error

An error was found in the test article microsequence logic where "Znnnn," which was used to represent a hexadecimal constant, was interpreted by the compiler as a variable name. This caused values to be written to an unknown hardware address since the variable was not initialized with any known value. This error was discovered while running in simulation mode and the message "Illegal digital output address" occurred. "Znnnn" was changed to "4Znnnn" to fix the problem.

Intermittent Link Problems

Link problems plagued the start of the Enhanced Flow Compressor Test. At the end of the first week, about 20% of the once-a-second messages from FCC1 to the Monitor failed to get through. Diagnostic tests found no errors and the link was not "out of tune." When the cables and DIP switches were exchanged between the two link controllers in the Monitor, the problem moved to the other link. This indicated that the problem was in the link controller. Although it was replaced with a spare controller and it worked, three days later it failed intermittently. The controller was replaced again and the problem has not reoccurred.

TAC1 Hardware Problems

TAC1 experienced a series of hardware problems at the beginning of the test. At least two floating point boards went bad. One intermittent problem remains. The CPU, EAU, private memory boards, and disk controller have all been swapped without affecting the problem. Remaining possibilities include RMPI, LMPI, backplane, and cables.

Precursor Stall

Improvements were made to the precursor stall detection algorithms and the data file format. The format was changed to minimize disk space requirements.

The Recursive Maximum Likelihood algorithm was incorporated into the identification routines. This algorithm is still being tried as numerical instabilities have occurred with some initial parameters.

Several methods for finding the roots of a complex polynomial were tried and most had problems. The Jenkins-Traub method is now being used. It is computationally demanding; however, it has not failed.

Several methods for tracking the polynomial roots have also been tried; however, these methods experience problems when the roots cross paths. Although it is not a necessity, it is desirable to be able to track the polynomial roots.

Appendix D

Delivery Order No. 4

Data Acquisition and Analysis Enhancement

Data Acquisition and Analysis Enhancement

In support of the CRF computer upgrade, Battelle provided development, modification, and redesign efforts to maintain the readiness and enhance the capabilities of the Compressor Research Facilities' (CRF) embedded computer and instrumentation subsystems.

Under this Delivery Order, Battelle purchased the following items to continue the implementation of the CRF computer replacement.

- Transceiver Cables and Fiber Optic Jumpers
- Burst Spectrum Analyzer
- HP Laserjet Printer
- 12 Xterminals, Additional Memory and 4-Port Transceivers
- 16MB VAXstation Memory for VS1 and VS3
- LNO3 Printer
- 4 DEC Etherworks Boards
- DataViews for LAV and VAX 4000
- Masscomp 6450
  - Removable Disk Canisters
  - Array Processor, C Compiler, and Development Tools
- 2 DEQNA to DELQA Upgrades
- RTF Client and Server
- IEEE 488 Drivers
- VAX 4000 -- 16MB Memory
  - 128MB Additional Memory
  - 2 Unclassified 1.2GB Disks
- Two 4mm Tape Units and 60 Tapes
- Infoserver
  - Tape Facility Software
  - CDROM
- Network Software
- Preston/Computer Interface -- GMAD
  - Digital Cards
  - DEC 4000 Turbo Channel Adapter

Logical Company DCT1000 VMS (DRV11 Card Into Turbo Channel)

IOTECH -- 71B Control Room Audible Alarms

Initial CAMAC Buy -- SHD and 1 Crate

VAXELN Toolkit

2 Fiber Optic Repeaters (71B Floors)

RTVAX 4000 Model 200 and Rack

Winchester Disks

Tektronix Color Plotter and Supplies

Lantronix -- 1 – 16 Channel Terminal Server and 1 – 4 Line Terminal/Print Server

VAX Line Printer

2 Gateway PCs

These purchases and their installation continued the process of reallocating and merging the functions of several CRF computer systems into one system.

Appendix E

Delivery Order No. 5

ADLARF Test Support

ADLARF Test Support

ADLARF Test Preparation

Security plans were written and approval was received to process confidential data on the VAX 4000 (VS4) and LAV systems during the ADLARF test. Declassification procedures and drawings were updated as required. Procedures were written to perform facility data file maintenance. Classified and unclassified disk systems were built for VS4 and the Monitor computers.

Two training sessions were conducted on the use of the VAX, Facility Graphics, and event logging. All computer operator notes were modified, and a consolidated set of notes was generated to help train a new VAX operator.

The LAV VAX VMS operating system was upgraded. The IEEE-488 interface and drivers, DataViews, and a LNO3 printer were installed. Software and hardware were then configured for laser data collection. A virtual RS-232 communications line was installed between the LAV on the "unclassified" LAN to the VAXes on the "classified" side. This line provides communications during unclassified CRF online processing. Software was designed and written to allow VS4 to communicate with LAV via RS-232. All software was debugged and the Test Article Graphics task was modified to allow laser data to be plotted.

Test Manning Support

Minimum manning test support was provided for the Laser Operator, Kulite/Aeromechanics Engineer, and Test Engineer positions.

Facility Support

The Control computers encountered hardware problems which included cabling, fusing, fan noise, and card failures. Problems were also encountered with Control computer shared memory and the Monitor memory power supply. Link problems occurred between the two buildings, and the line printer on the Control computers was down for a short time. All these problems required time with maintenance personnel to help run diagnostic tasks or provide access to the facilities.

Kulite Data Processing

Software was written to perform contour and surface plotting of Computational Fluid Dynamics (CFD) and acquired Kulite data for comparison of theoretical and actual tip pressure. A contour plotting program for regular grids was modified for the irregular CFD grids and an option for a simulated contour plot which would result from a fixed number of Kulites at equidistant spacing was added. An algorithm to allow irregular CFD data to be fitted to a smooth surface with a regular grid defined by the user was also added.

A problem with inconsistent data processing in the Campbell diagram software on the Analog Tape Digitizing System (ATDS) was discovered. This was resolved by recompiling the program to fix a corrupted executable file.

For Kulite data plotting, an interface to Concurrent's Lab Workbench was added so that data could be read from Lab Workbench files. Data reduction and plotting were also performed. Time versus pressure plots for 16 different case-mounted Kulites were produced, and the data was used in a spatial Fourier transformation program to try to identify rotating waves prior to compressor stall. The existence of rotating waves prior to stall was clearly demonstrated in several cases.

The Transient Pressure Data Analysis task (over-the-rotor Kulite block) required the reduction of analog recorded pressure data (from the ADLARF test program) and the presentation of this data in an appropriate graphic format. Static pressure data acquired under 15 different test conditions was processed, graphically presented, and analyzed.

Stalling Stage Determination

Data from the stall precursor study was used to determine which stage stalled first during the ADLARF test. Since the stalling behavior of the compressor depends upon the operating speed and the configuration of the machine, either of the two stages could have stalled first. Determining which stage stalled first is critical to determining whether the casing treatment study should continue if ADLARF testing is resumed.

Blade Surfaces Pressures Analysis

A study was performed on the unsteady blade surfaces pressures resulting from inlet pressure distortion. These unsteady pressures were measured with high-response pressure transducers mounted on the blade. From this study, an in-house procedure was developed to acquire, reduce, and analyze these unsteady pressures. Unsteady blade forces and moments were also determined. A report was generated which detailed this in-house procedure as well as the actual analysis of the unsteady blade forces and moments changes due to inlet flow field variations.

Trouble Logs

Trouble Log #9225401

Facility Graphics TALO Return screen requires the addition of the delta-P (Pressure) across the TALO air/oil separators.

The alarm fault will be an E-Stop at 9 inches water, the warning fault will occur at 11 inches water.

The bit state was determined (bit set (1) = OK, bit reset (0) = fault state) and the readout location and actual device appearance were configured. Control lines for the delta-P were installed and the vent pipe location was changed. Software and documentation were updated.

Trouble Log #9225402 & #9225403

Long delays occur between the time when the facility panel is armed and when the sequence is accessible. Also, delays occur when other control buttons are pressed on the Facility Operator's panel. The problem is related to FCC link-up trouble.

Facility Graphics periodically flashes alarm in computer status screen. Reason was seen as PLCs, FCCs, and TACs as "???" (state unknown), then quickly returned online without E-Tripping the facility.

The Monitor side of the FCC1-Monitor link was faulty which inhibited updates from FCC1. The link was repaired.

Trouble Log #9226002

The Base Peak MTD power number changes without entry. It appeared to change after facility restart.

The Base Peak MTD (month-to-date) power number **should** be overwritten when a greater value occurs; however, the estimators caused unrealistically high values to be stored for some of the 30-second updates. Two additional estimators were written. One estimator backs up the original estimator, and the other estimator allows the operator (at the Monitor terminal) to input an estimated background value when the modem stops sending updates.

Additional problems which occurred when the 30-minute time frame would not reset when the period broke exactly on the 1800/0000 second mark (causing a new peak to be set) and with communication between estimations were also been resolved.

Trouble Log #9228006

On the TALO Return screen, FE07 indicates negative (-) and should be positive (+). Also, the flow is changing too much and is out of range of the pump system.

The coefficients for slope and offset on the delta-P transducer had changed. These were adjusted.

Trouble Log #9228101

Remove valves ZSH-17 and ZSH-12 from the Hydraulic screen. These two valves have been moved and no longer have position switches.

Removed ZSH-12 and ZSH-17 from the Hydraulic screen.

Trouble Log #9228102

On Drive Lube Oil - 3 screen, modify VA2 display to show OPEN and BYPASS conditions; maybe fill with green.

On Drive Lube Oil - 1 screen, the vent symbol has two meanings: vent and return to tank; no matching point in the tank.

On Drive Lube Oil - 3 screen, the different "arrows" of the VA2 valve will now be the color of the background of the condition block.

Drive Lube Oil - 1 screen, added a blue arrow as the tank return and created a corresponding arrow coming from the tank.

Trouble Log #9228103

Drive Lube Oil - 3 screen, PIC04 should be PDIC04.

AUX Air screen, when ZSH80 is green it should read "Closed" and show as a relief valve.

Modified the software and screens as appropriate but did not modify the symbol in the AUX Air screen since there is no relief valve in the graphics.

Trouble Log #9304002

RTD-35 was destroyed. Remove from limit checking.

RTD-35 was changed from "ON" to "DIS" in the limit-check database and was flagged as black on a white background on the High-Speed Gearbox - Temp screen to signify that it is off.

Trouble Log #9304003

RTD-201 is not being used. Remove from limit checking.

Changed RTD-201 to "DIS" in the limit-check database, changed the header to black on white (off) on the Pedestal - Temp screen, and flagged RTDs 202_206 as "off" on the screens.

Trouble Log #9304301

Power Demand screen value Base Peak MTD changes to the wrong value (not as input).

The scale factor was changed.

Trouble Log #9305001

Need to change the status colors on the Facility Sequence screen. The light blue and green colors are very close.

Modified the software to use a bright-green screen color rather than the standard green color that was being used.

Trouble Log #9305002

RTD-09 picture (Pedestal - Temp screen) should be moved. RTD-09 is between bearings 1 and 2 on the jack shaft. Picture shows it on bearing #1 and the printout says bearing #2.

Moved graphical depiction to between bearings 1 and 2. Changed the text to read "bearing #1."

Trouble Log #9306405

Screen, screen description, and facility database do not match. Problem statement should read: Header labeled TC117 on TALO Supply screen, doesn't match facility limit-check database or descriptor field in the information window. It should read "nnnnnnnns."

The TC117/TT113 disparity remains because one is the controller and the other is the transmitter. The header name was changed in the limit-check database from "TALO RETURN TEMPERATURE" to "TALO SUPPLY TEMPERATURE."

Trouble Log #9306701

Facility Graphics for TALO needs chip detectors added.

Chip detectors (with fault set condition) and delta-P sensors (with fault reset condition) were added for chip detectors 1 through 4. These were modeled after a similar bank in the DLO system on Drive Lube Oil - 3 screen.

Trouble Log #9306802

A blue "4" appears on Drive Lube Oil - 2 screen between LSGB and HSGB. Can't read PSL#; need blue "4."

Modified the software to write "PSL04" or "PSL05" in white on black rather than just writing the final number of the PSL0*n* string.

Trouble Log #9306804

Slip Ring screen # is red when the condition is OK (from front slip ring).

The annunciator showed an alarm because the logic was duplicated for 16 headers on the screen. The fault logic picked up one set of data and the screen picked up another set of data. Sixteen data types in DBFS_INPUT.DATA were reset and two subroutines in FACRED.FOR were rewritten.

Trouble Log #9306912

CC Level Test screen does not give correct readings during critical channel check.

This module was rewritten to correct the problem. See Trouble Log #9306913 for further information.

Trouble Log #9306913

CC Level Test screen did not show proper values. Correct values were shown on IBM and Control computers.

Modified software to correct this problem.

Trouble Log #9307005

SV/SB Control screen does not show correct stator setting. SV/SB Channel 1 doesn't agree with SV/SB Channel 1 screen. Also, percent corrected speed is not right on SV/SB Control screen and icon location is not correct.

The location checked the status rather than the value. Percent speed was based on 16,821 rpm rather than 13,288 rpm. These problems were corrected.

Trouble Log #9307401

Slip Ring screen, CRF power on Sub C (Sub C 30 MVA Trans screen), does not match data on Power Demand screen.

We were running an average of 5 MW on Sub C. Power Demand screen showed less than 1.0.

The average power was erroneously being divided by time in the figure sent to the VAX. This problem was corrected.

Trouble Log #9307402

ZRE-69 LSGB reading -0.201, all others reading 0 when system not running.

Changed the slope and offset (offset changed significantly).

Trouble Log #9307406

RTD-34 was physically damaged and can't be repaired. It should be eliminated from limit checking. The value should be eliminated from the screen.

RTD-34 is on the high-speed gearbox.

M10-TIT-34 was eliminated from limit checking (for A, B, and C) and the header was deleted from display on the High-Speed Gearbox - Temp screen.

Trouble Log #9308102

Drive Lube Oil - 2, PSL04 on HSGB is mislabeled; it should be PSL104.

The title was renamed to PSL104 and PSL05 was renamed to PSL015.

Trouble Log #9308105

Please provide a way to initiate Facility Playback when there is no TMT icon.

Ask the VAX operator to initiate Facility Playback.

Trouble Log #9308904

Suggest pushup count be put on the Facility Graphics (Electrical Drive - 1 screen).

The pushup number was added on Electrical Drive - 1 screen. The number now appears below the string "Pushup" (on the right of the frequency converter).

Trouble Log #9309001

The barometer signal is not getting through to the Main.

Two problems were found while running TDG and troubleshooting the supply voltages: a power supply had a bad circuit card, and a blue hood was loose on the multiplexer which led to the expander in which the barometer signal is read. Both problems were resolved.

Trouble Log #9309004

On Electrical Drive - 1 screen, pushup indicator does not zero out at end of pushup set. It will go to zero when switching to another screen and then returning to the Electrical Drive - 1 screen.

A null character was placed at the end of the string after filling it with blanks and entering a new value; the null string had been placed directly after the value which did not totally erase the previous string.

Trouble Log #9309106

Modem down. Data still or in serial window. (Data appeared in the serial window but the Power Demand screen said the modem was down.)

The RS-232 plug to the computer was disconnected.

Trouble Log #9309107

Fix Event Logger so that it does not return to last event when a new message comes in. Currently, it is impossible to review Event Logger while running because new alarms reset Event Logger to the bottom.

Currently, the Event Logger can be viewed two ways. To view a hard copy, print out the Event Logger file. To view it online without returning to the last line, select "Display" from the "Customize" window menu. Then, click "Vertical Cursor Coupling" to deselect it. The cursor will still scroll, but will not return to the last line. Do not leave this option on since new faults will not be seen as they occur.

Trouble Log #9309203

Stator vane schedule on SV/SB Control screen needs to be changed due to switching blisks.

Modified the appropriate software and screen.

Trouble Log #9309506

Power Demand screen: CRF peak power not being displayed. We were running at least 15 MW, screen showed 0.388 for today's peak.

The software problem was identified, corrected, and tested.

Trouble Log #9309605

The IDARS datasets are often digitized with extraneous data. IDARS provides no way to trim the excess data off the beginning or end of a test (or both).

Software was written to allow the user to specify a range of an IDARS raw data file to keep while copying the data to a new file.

Trouble Log #9309902

Bldg 20A Drive Vent screen, FS05 and VM-2 show white, should show green when running.

Software modifications were made so that FS05 will now show green if the high-speed motor is selected and on, yellow and "LOW" if the high-speed motor is selected and off, or white if the low-speed motor or no motor is selected.

VM-2 has only two modes: black on white "CLSD" and white on black "OPEN." If a green condition for VM-2 is wanted, an additional trouble log must be submitted.

Trouble Log #9310203

The Masscomp experiences system "hangs" under conditions of heavy disk I/O. The file system keeps becoming corrupted.

System diagnostics were run, the disk was reformatted, and a new file system was created. A "file system check" error message continued to occur while performing normal tasks. Concurrent's technical support stated that this type of problem is normally hardware related and recommended that the disk controller, CPU board, and power supply be swapped to isolate the faulty part. Concurrent swapped the disk controller.

Trouble Log #9310302

The AUX failed and wouldn't reboot.

A bad 30 amp fuse in the power supply was replaced.

Trouble Log #9310902

Power Demand screen: Power demand, time present power no peak shows up to 80 minutes during period. Period is only 30 minutes long. Indicator is to display time relative to present period.

The software logic was changed to display only the current period if power will not be able to be maintained for the remainder of the period without a peak.

Trouble Log #9310904

The Masscomp experiences system "hangs" under conditions of heavy disk I/O.

These types of problems are difficult to diagnose and the only way to resolve them is to swap the disk controller, CPU board, and power supply until the faulty part is found. Since the disk controller was recently replaced and system hangs still occurred, the CPU board was now replaced. File system checks and repairs were performed to repair the existing file system. The system hang problem has not reoccurred.

Trouble Log #9311201

D33:PLC2 latch bits for Main DLO Heat Exchanger and Auxiliary Oil Heat Exchanger are the same. We should use different latch bits.

Modifications were made to the software and the Drive Lube Oil-2 screen to rename and change the address of the AUX water detector to 1149,08 (#07610) from 1150,08 (#07710).

Trouble Log #9311801

Need stall precursor programs to work with binary data. The program must also be modified for multiple stage data, and all stages are to be kept in the same data files for each step of the process. The model's output must be changed to damping coefficient and phase speed instead of pole position.

Software was modified for binary data and for multiple compressor stages.

Trouble Log #9311906

When the middle mouse button is clicked on a Facility Graphics header to generate the Header Information Window, it would be useful to see the header limits for the headers with limits.

Also, more information on the action codes (such as what action will be taken and how long this action will happen) would be helpful.

A new information screen containing limits and actions information was developed for the limit-checked headers. Information about speed-specific headers (which have limits that change with the speed) will also be available. The speed points will be defined as related to the Test Article or Drive Motor speeds. The action time involved was not included because the software can bring the facility to Idle Speed, Min Speed, or perform a stop or trip when an alarm fault occurs and these conditions do not have a time frame associated with them.

Trouble Log #9312301

Control computer tape drive does not work. Trying to use the tape drive during a facility run appears to cause TAC2 to fault. Also, tape runs continuously forward. Re-booting all computers did not help.

MFSI reconnected a loose cable in the tape drive and ran diagnostics on TAC2. Changing the TAC2 EAU board corrected the TAC2 problems.

Trouble Log #9312605

Unit #351 graphics not working properly. Top bar green. Where green boxes should be are white. Tried to re-set, re-start, etc. and it would not. Looks like green playback.

The terminal was stuck in green playback mode so the Test Operator Xterminal Control menu was used to resolve the problem. The Quit button was removed from the Test Operator Xterminal Control menu so that the problem will not reoccur.

Trouble Log #9313001

Main-Monitor link went down. Rebooting and powering down the Monitor did not help. Other Monitor links were functioning.

Could not repeat the problem. It is possible that the problem occurred because the IBM "boxed out" the Monitor. A new procedure was added to the Operator's Notes to help troubleshoot link problems if this condition occurs again.

Trouble Log #9314601

On Bldg 20A Drive Vent screen, FS150 is yellow. The annunciator for this screen is neither yellow nor blue.

This was caused when the system ready bit was not set for the microsequence which was being monitored. Different approaches are being considered for a solution to the problem of the bit latching/unlatching in a fault condition. Latching these bits at the wrong time results in false faults showing on the graphics. The current condition avoids this situation.

Trouble Log #9316102

FCC2 Low Ref Volts (Displayed on Computer Network screen.)

The high (8.00) voltage was adjusted on the FCC2 WRAIS. Voltage reading at 7.905 (warning at 7.90 and alarm at 7.80). During the run, it was at 7.88. Now it is set at 8.075 with a high warning at 8.20 and alarm at 8.30. The air conditioning failure in the balcony may have caused the problem.

Trouble Log #9316104

On Test Operator's CRT, Electrical Drive-1 screen was displayed. Screen was frozen. Values were not updating. Time display was okay.

The problem did not reoccur when playback was run, and a software check did not reveal any problems. Investigation will continue as time permits.

Trouble Log #9316601

Change Frequency Converter Cooling screen for DC Motors from "CO G" to "DC MOTOR."

The Frequency Converter Cooling screen was modified as requested.

Trouble Log #9316602

VM-2 shows white on Bldg 20A Drive Vent screen. To be consistent, should be green when system operating.

Software was modified for VM-2 to show black on green "OPEN" when on and black on white "CLSD" when off. The software was tested and promoted.

This is a display change. The old Color Graphics system displayed VM-2 as black on white "OPEN" when on and white on black "CLSD" when off.

Trouble Log #9317201

Need to convert ATDS data (UNIX format) into a form that can be used on a PC. (DOS; ASCII).

A Kermit station was set up to easily transport files from the Masscomp to a PC.

Trouble Log #9319501

Five text files need to be translated from DOS text into MAC text.

Blade Kulite data files were translated from DOS ASCII to MAC ASCII as requested.

Trouble Log #9320801

Transfer source code from a VAX to a PC for SFT of Kulite data from ADLARF.

Transferring the source code required major modifications due to dependencies on DataViews and VMS; therefore, it was decided to leave the software on the VAX and process the data there. Modifications were still necessary due to numerical instabilities of the bandpass filters used in the digital filtering program. The program and libraries were modified so that critical variables use double precision. Extensive testing was performed to find the optimal filter order.

Trouble Log #9321602

At 0 rpm, ZRE-69 reads about 0.50 mils.

Channel ZRE-69 was recalibrated on FCC1, and the database was generated and tested.

Trouble Log #9322101

To continue our inlet pressure control project at AFIT, we need to know the current schedule of the inlet valve position versus index for the five inlet valves.

This will be used to develop the software to control the inlet valves to provide a desired inlet pressure.

The schedule, which includes space for 30 X and Y values for each of the 5 valves, has been provided. Software was written to provide the valve position at every 0.5% of the valve index.

Trouble Log #9323102

M11-PDIC04 has repeated warnings. Keeps hitting low warning limit of -8.00. Recommend consideration of limit change unless real problem that needs to be addressed.

Actual value goes down to -8.1 sometimes. This causes repeated warnings on the Event Logger.

The software was modified as required.

Trouble Log #9323105

When PDIC04 goes into warning on the Drive Lube Oil - 3 screen, the Event Logger displays a message for M11-PT-3. Information on the screen and in the Event Logger should match.

A reference to PDIC04 was added in the descriptor message for both the setpoint and the reading so that the screen and Event Logger would match.

Trouble Log #9323201

ATDS software needs to be revised for ADLARF data.

The users were shown how to modify the parameter files for the ADLARF Kulite arrangement. The DFT and filtering programs were modified under Trouble Log #9320801.

Trouble Log #9323502

On shutdown, speed control went into alarm.

This occurs when running at slow speeds just prior to speed being calculated from the frequency converter. At the low speeds, the 1/REV signals are not good. TAC1 feedback still has intermittent problems even at full speed.

Trouble Log #9323603

A failure occurred on SV/SB feedback. (TAC1 A, TAC2 B, TAC1 C were not working - stator didn't move.) This caused an alarm on the SV/SB Control and SV/SB Channel 1 screens. Both screens showed alarm, but the annunciator for these screens did not turn red.

The appropriate software logic was modified. Previously, the computer checked if the system ready bit was set prior to checking for faults. Now the system ready bit will be checked and then sequence faults will be checked. The appropriate screens will light if there is a sequence fault condition. The problem was caused when the system ready bit was not set and the annunciator was not aware of the fault.

Trouble Log #9323604

Change database limits as required.

The database was changed as required. Software was modified as appropriate for these changes.

Trouble Log #9324401

After an E-Stop, VS4 started updating very slowly. Each screen that was displayed had a different time. Screen prints could not be generated.

The problem could not be repeated after the VS4 was rebated.

Trouble Log # 9325003

The portion of the graphics screen which emulates the physical system freezes occasionally while the annunciator performs as expected.

The Computer Network screen showed a fault in the annunciator with no faults visible in the system emulation portion of the display. A second Computer Network screen showed failures in both the annunciator and the system emulation portions of the display.

This error probably occurred in a setting where the number of headers is zeroed prior to a routine call. When the routine returns an error, no updates are possible. The software was modified to correct this problem.

Trouble Log #9325801

Change facility database as required.

The database was changed as required. High warning was changed from -1.00 to -0.50; high alarm was changed from -0.50 to -0.25, DLO Return Slump Pressure, M11-PIC-04.

Trouble Log #9326701

The FCC2 display is not available in the Control Room. When VS4 failed, there was no way to tell the system status. A B&W system status is needed when the VS4 is not available. This information is normally on the FCC2 display.

The cable which sends the screen image to the Control Room had been removed from FCC2 and placed on FCC1. This cable has been switched back to FCC2 so that FCC2, TAC1, and TAC2 can be viewed from the Control Room.

The status display may be viewed from TAC1, TAC2, or FCC2. Enter the "STAT" command followed by the computer name to obtain its status (example, STAT TAC1).

Trouble Log –

The Noload facility historical data for February 9 had 2 records (instead of 1) for every second.

This occurred because a timer used during software testing had not been removed. The timer was removed and the software was modified.

Trouble Log –

Data for TAC1 critical channels is being stored in the wrong input buffer.

The TAC1 critical channels analog input controller was replaced by MFSI to try to resolve the occasional problem of data for channel *n* being stored in the input buffer of channel *n*-1. The new controller did not fix the problem; the temporary fix of reading one channel at a time was re-installed.

Trouble Log –

IBM 4381 to PC communications were established to support the execution of a parallel processing model during ADLARF testing.

Trouble Log –

When a hardcopy plot is requested in batch mode, it doesn't always print.

This occurred when more than five print jobs with the same name were trying to run simultaneously. Because the directory has a version limit of five, the sixth print job aborted when it tried to create its log file.

Trouble Log –

To prevent a facility historical data tape from accidentally being destroyed, the promotion script was changed to reject any tape without the "PROMO" label.

Trouble Log –

Problems with "leaky" capacitors and resistance problems were corrected in the TAC High-Level Analog Input Subsystem (HLAIS) and a modified controller for the HLAIS was installed.

Trouble Log –

Facility Graphics playback software was enhanced to allow the informational window to display the microsequence where limit checking begins. The former approach displayed a 3-letter code for the microsequence name.

Appendix F

Delivery Order No. 6

Functional and System / Network Manager

Functional and System/Network Manager

The following functional, system, and network management tasks were performed in support of the Compressor Research Facility (CRF). Battelle provided development efforts to maintain the readiness and enhance the capabilities of the CRF's embedded computer and instrumentation subsystems.

Modcomp

Preventative maintenance, software/hardware updates, and problem resolution were performed on all Modcomp systems. Hardware failures were resolved in conjunction with the hardware maintenance contractor. Software modifications were made as required.

As the computer upgrade continued and Monitor functions were migrated to the VAX, Monitor software and procedures were streamlined. Excess hardware components were removed to reduce maintenance costs and consolidate the system. The DAC I/O was consolidated from five racks to one and the Monitor I/O from two racks to one. This eliminated individual channel check enable signals for each channel thus making the hardware more reliable, freeing up spares, reducing maintenance costs, and simplifying interface testing. Monitor software was enhanced to force an E-Stop if the Monitor-to-VS4 link failed and to allow either FCC1 or the Monitor computer to be independently restarted.

A problem which caused TAC1 critical channel "data shifting" was tracked to the original software design. A trouble log was written to have it repaired.

Masscomp

A Masscomp 6450 computer system was received, configured, and connected to the CRF classified LAN. Removable disks were purchased and installed. A security plan was generated, an auditing script was built, and procedures were written for screen and printer declassification. Several hardware problems were encountered which were resolved by Concurrent.

All Masscomp and Creare software (including TCP/IP) was installed. A system backup was made, a backup script was created, and a backup tape rotation was established.

To support the speed up of Campbell diagram generation, the Vector Accelerator compiler and linker were purchased, installed, and tested.

Strain gage data acquisition and analysis software is being converted to run with release 5.0 of the RTU operating system. Problems were encountered with the Data Acquisition libraries and a temporary solution was supplied by Masscomp.

Kulite plotting software remains under development. A statistical algorithm was added to remove bad points from the ensemble average data.

PCs

An inventory of CRF PC hardware and software configurations was established to track and maintain equipment.

New PCs were configured as they became available, and miscellaneous software and hardware problems were resolved. An upgrade plan was generated to convert all POT PCs to 486 systems.

A PC is being setup for classified report generation. The hardware configuration was modified with new drivers and a removable disk drive. An additional removable disk was purchased to support unclassified PC operation. Security documentation and procedures were generated.

Pathworks was installed on VS2 to give PCs access to the LAN and VAXes. Five PCs were connected to the LAN and configured to access the CRF Pathworks services which include WordPerfect, Word, Alpha Four, Excel, PowerPoint, Harvard Graphics, Perform Pro, and several utilities. The user was also given the capability to maintain PC files using the VAX disk resources and to transfer files between the VAXes and PCs.

Training was provided to CRF PC users for the network applications and printers. User notes for the CRF Pathworks configuration were drafted.

VAX Systems

The VMS 5.5-2 operating system was installed on all VAX systems, FORTRAN was upgraded to 5.9, system backup procedures were upgraded, and hardware and software configuration files and documentation were updated. All VAX disks were inventoried and new labels were created. System startup procedures were modified to reflect changes for online processing.

The VS4 system was configured with DataRAM memory, a turbochannel adapter and DCT-1000 interface, Winchester removable disk chassis, and 4mm DAT tape drive. Configuration problems were encountered with VS4 and various controllers on the system. Problems were linked to an incompatibility between the VMS drivers and the third-party TurboChannel adapter. DEC supplied a patch to resolve the problem. The operating system, FORTRAN, C, DataViews, disk, 4mm, Xterminal, TCP/IP, and terminal server download software was installed. Accounts were transferred from V6. Several hardware problems were encountered and resolved.

Window management benchmarks run on VS4 showed that it is up to 12 times faster than V6.

Disk I/O and low-level X window operations ran at about the same speed on both systems. VS4 was able to support 90 Facility Graphics windows updating once every 2 seconds with the CPU only 6% busy while the V6 was 91% busy with 55 windows running and response time for the 55th window was over 1 minute.

The InfoServer 100 was installed on the network and a disk was connected to it. Hardware problems were resolved with DEC's help. Software upgrades were installed on the InfoServer and InfoServer Client as they were received, and a backup service and procedure were created. The functionality of the InfoServer expanded to be able to access most of the DEC manuals online.

The PPX VAXstation was relocated to better accommodate secret data processing. Hardware problems were resolved with DEC's support. The operating system and all the supporting software was rebuilt for the system, a 4mm DAT tape drive was installed, and an unclassified Pratt & Whitney proprietary disk was built.

During a system move all data on the LAV VAXstation disks was lost. Disks were reformatted and the operating system was restored. All system and layered product software was updated, and a classified system disk was built.

Networking

Network problems continued due to the inadvertent distribution of LAN addresses to multiple users by DOIP.

Installation of direct CRF access to the Area B LAN fiber ring is now being completed. The design and layout were finalized, and fiber was installed between Buildings 20 and 71B for the connection of the CRF to the Area B fiber ring and from Buildings 71B to 20A. Jumper cables were fabricated to run from the communications closet to the actual devices. Router and network management/addressing information was received. Upon completion of the router and address installation the DOIP broadband and cut-off switch in the secure CRF area will be removed to simplify security and allow the unclassified CRF LAN to have outside access during classified processing. The CRF's direct connection to the broadband will also allow direct access to the ASD computer center for problem solving. The Building 20A LAN is being made permanent. Cabinets are being configured and equipment is being mounted. Fiber optic jumper cables required for communications in the Control Room and Building 20A were specified, procured, and installed.

In order to provide online test monitoring capabilities to Test Article vendors, a study was performed in conjunction with GE to evaluate available encryption equipment. Motorola NES equipment was selected, purchased and mounted. A connection to ASD's T1 link is also required and was researched. Testing will be performed when the CRF LAN is restructured with router access to the Area B fiber ring.

The Tektronix Phaser II PHi color plotter was installed on the CRF LAN. A Printronix 4280 line printer was connected to the CRF online LAN through a printserver, and the printserver and print queues were configured on all systems.

To support office module installation, LAN needs were estimated and a floor plan was generated to show the relocation of the LAN and equipment during the setup.

A LAN cabinet was purchased and installed for the Control Room LAN equipment. It will hold all current LAN devices including the encryption equipment and has sufficient room for future expansion.

The CRF online LAN was extended, and the transceiver and physical connections to the Masscomp were provided.

All standard system/network management support (including monitoring, tuning, documentation, and users' assistance) continued. Trouble-shooting and repairs were performed as required.

The Lantronix EPS4D print server and ETS16D terminal server were received, installed, and tested.

Day-to-day network maintenance and assistance was provided. An Ethernet LAN backbone was installed between SCR floors, and fiber optic repeaters were installed to link the SCR to the CRF LAN in Building 71B.

Transceivers and cables were installed for four additional Xterminals which were placed at the Test Operator's station.

Xterminals

Shelves were designed to allow an Xterminal to be mounted in 19-inch racks. Shelves were designed for use at the Aero, Drive and Test Operator's stations.

Eight new NCD19C Xterminals were configured, an additional 4MB of memory was installed, and the Xterminals were connected to the network. Several power supply failures have been encountered and the warranteed units were repaired.

Critical Channel Buzzer

An IOtech Digital-232 was installed on a terminal server for use with critical channel alarms. The setup was established and software was implemented to trigger an alarm box controlled by the

IOtech. A two-tone buzzer box was constructed to replace the Monitor I/O warning buzzers on the VAX system.

Software Management

A software management tool was developed to compare application files. This tool compares module creation dates and performs a source code line-by-line comparison. It has been used to uncover several discrepancies in the DataViews binary view files. A utility subroutine was written to simplify the association of a DV-Draw DataViews variable with a FORTRAN program variable. Procedures were written to check out application modules or data files. Procedures were also written to prevent unauthorized software promotion.

The directory structure was modified to maintain a relatively stable and thoroughly tested copy of the application software as well as a version of the software with generic data which can be used for tours.

Procedures were written to send a set of Modcomp source libraries over Ethernet to the VAX. All Modcomp source code was copied to V6.

All VAX FORTRAN software was examined to ensure each module contained an IMPLICIT NONE statement. This statement will cause a compilation error if a variable is not declared and help identify problems when wrong data types are used.

Software was modified to simplify mapping to a global section. The new subroutine specifies the name of the section instead of its number. It also allows a section to be mapped as read-only to minimize the possibility that an error in one program will cause other programs to fail.

Software, procedures, and instructions were written to copy 800 bpi facility historical tapes to 4mm tape. A subset of the old 800 bpi tapes was selected and archived.

Documentation

Computer and Control Room floor plans were updated to include Ethernet and fire detection systems.

Security plans were generated for LAV and the VS4. Floor plans, system configurations, and operating procedures were updated.

Online documentation is being generated for end users and programmers. A series of graphic help screens were designed and implemented. These will help users understand how the user interfaces work with the terminal menu screens, facility information displays, and facility playback control.

Online help documentation was generated for Test Article database file structures. The functional documentation for the Master Control Program, Event Logger, Test Article Graphics, Facility Playback, Facility Graphics, Start and Stop A Task, Facility and Trend Plotting, Test Operator Xterminal Control, Data Operator's Screen, and Terminal Menu Task has been finalized. Functional documentation for Stall is in progress. Documentation charts, software headers, and programming standards were reviewed. Weekly meetings were held to review software progress and discuss pending issues.

Software

The Monitor Event Logging function was migrated to the VAX. The last 9,999 messages will be displayed in an Xterminal window, stored on disk, and can be printed by a Facility Engineer at any time. Messages were expanded and enhanced to print a message for every header that goes into alarm or warning, and software was added to clarify the reason for test termination.

Detailed documentation of the Modcomp/Ramtek system was generated to support the migration of the Facility Graphics function to the VAX. Software design and development was completed for Facility Data Acquisition, Reduction, Storage, and Display for all Facility Graphics screens.

Monitor software modifications were made to allow setting and resetting microsequence system ready bits in support of Facility Graphics, Alarm Checking, and Event Logging testing.

The new Alarm Checking function design was finalized. Design considerations included identifying which headers need to be alarm-checked, coding each checked variable to prevent premature checking, generating a new database file structure for each checked variable identified by the microsequence at which the checking is to begin, identifying which screens are active and are available to Alarm Checking, describing the "type" of each fault so that the action on the fault is correct, identifying alarm-checked headers which appear on more than one screen and allowing acknowledgments to affect these headers on all screens, calculating fault severity or acknowledgment and communicating the fault status to other modules, and answering questions about the present and developing system during the checkout and creation processes of the new system.

The Test Operator's Xterminal Control function was implemented. This included a graphical user interface which allows the Test Operator to control the four Xterminals at the Test Operator's station.

Test Article Database Generator modifications were designed and software development was begun on the database generator. Twenty-nine database files needed for data reduction can now be successfully generated. All IBM data reduction software was transferred to the VAX. Software interface routines were written for the data reduction software to allow data retrieval from the new database files. The reduction software, new database files, and data retrieval interface routines were successfully compiled and linked on the VAX.

The Test Article Data Playback task was completed. This task allows a user to select the reading number to be processed and the database file to use when processing the data. It will run online or during post-processing.

The Test Article Data Control task was completed. This task controls Test Article data acquisition during a compressor test. The user will be able to select data acquisition rates, acquisition formats, and Scanivalve data to acquire monitor, static, transient, channel check, and pressure calibration data.

Software design for the Test Article Data Raw Counts Storage task was completed. This task separates the data into three disk files. The first disk file will be used for monitor data acquired at a one scan-per-second rate. The second file will be used for monitor data taken at faster rates and for transient data. The third file will be used for static, channel check, and pressure calibration data. This task will allow a more efficient means of data playback and storage. Software development is in progress.

Software design for the Facility Data Playback Control function was finalized. This task allows two playback sessions to run concurrently with the online data acquisition, processing, and display software. The Facility Database Generator was expanded to create the required database files to perform data playback during online data processing. Graphic screens were designed, developed, implemented, and tested. Numerous enhancements were made to Facility Graphics playback on the VAX.

A Compressor Data Alphanumeric Display task was developed to allow the user to view compressor data during testing and playback. This task will incorporate Database Parameter Display, Out Of Limits Display, Automatically Deleted Header Display, and Database Parameter Modification Display. It will allow users to view counts, engineering units, corrected engineering units, uncertainty data, noisy channel information, delete code data, and database file structure data. It will also allow the user to modify the delete code, delete code reason, and delete code resolution database file structures and then tag the new disk file with the current reading number so that the modifications can be tracked.

To fine-tune online software control, the VAX system was modified to allow some VMS commands to be executed from the master Xterminal menu without logging on as a separate job. These commands include "show process/continuous" which can only be done from the same user account that created the process. In addition, the operator is now able to kill a process that becomes caught in an infinite loop.

The reset command at the Test Operator's station was deleted. Previously, when a Monitor alarm fault occurred it was necessary to press the button and type "RST" to reset it so that a second alarm could occur. Now, only the button press is required.

Software was written to move the cursor on the four Test Operator Xterminals from the screen center to the corner so that it wouldn't appear in the middle of the displays.

The design of the Modcomp-to-VAX Data Acquisition conversion was finalized and the digital input portion of the Preston Presys 1000 was tested. A fiber optic interface is being installed and tested to support the operation of the Presys in Building 20A in conjunction with the VAX in Building 71B.

Link statuses for the IBM-to-VS4 and LAV-to-VS4 links were added to the Computer Network screen.

Facility fault checking software was coded, modified, and tested.

Software design for the task that will read the Preston has begun. A skeleton program was written that will read data from a disk file and then send it to the task that records the raw data on disk. This program will be used to test the buffering system between the raw data acquisition task and raw data disk storage task. It will also be used to test the use of event flags to synchronize tasks associated with data acquisition and compressor data storage.

Programs and procedures were written to allow PLC ladder diagrams to be printed from the VAX. The PLC ladder software still runs on the Monitor; however, the output is assigned to a file which is then copied across Ethernet to the VAX and printed. The same logic can easily be used for any Modcomp printout.

The Facility and Trend Plotting function was enhanced and migrated to the VAX. This software allows a user to generate plots from facility historical data files and comprises more than 30 subroutines. Enhancements were made to the way in which the user inputs headers, the way input facility historical files were specified, and the way the plots use time.

Precursor Stall

Modifications were made to the stall precursor identification programs to make the programs use binary data only to handle multiple stages of sensor data and enhance the model output.

Preston Analog Input System

A phased upgrade plan for the Preston analog input system was generated using Preston's input. The plan was then discussed with Air Force personnel and the custom hardware was ordered.

Fiber optic modems will be used for communications with the Preston analog input system.

A diagnostic was written to test the communications and ensure that data would not be lost (e.g., dropped by the fiber optic modems) between scans. Software was also written to verify the size of the FIFO buffer within the Presys. The modems arrived and were tested; however, problems were encountered. The vendor was contacted and the modems were returned for design flaw repair.

The DAC IOIS replacement hardware is being configured. A special cable was fabricated to allow the IOTECH to communicate with the relay output board. A power supply has been purchased and adapted for the relay output board. The board has been mounted and is currently being tested. The PCAL and channel check system blueprints have been examined for the installation.

Due to the increasing failure of the Aero Station Tektronix 4632 hardcopy device, a viable replacement is being researched. Additional information and quotes are being obtained.

Appendix G

Delivery Order No. 7

Data Acquisition and Analysis Enhancement

Data Acquisition and Analysis Enhancement

In support of the Compressor Research Facility computer upgrade, Battelle provided development, modification, and redesign efforts to maintain the readiness and enhance the capabilities of the embedded computer and instrumentation subsystems.

Under this Delivery Order, Battelle purchased the following items to continue the implementation of the computer replacement.

- Network Components
  - Transceivers and Cables
  - Terminal Server and Print Server
  - Fiber cable for Bldg 71B, 1st and 2nd Floor Communications
  - Computer Interface Cards
  - DEC Repeater / DEC Bridge
  - LAN Rack
- Masscomp Disks and Postscript Driver
- 4 NCD Xterminals and Maintenance
- Tektronix Phaser II PXi Color Plotter Supplies
- Presys Customization
- CAMAC I/O Hardware
- 4mm, 8mm, and Cartridge Tapes
- PV Wave License Transfer
- 8-User VMS License for VAXstation 4000-200
- VAXstation 3000 Model 600S (VAX 6000 Upgrade)
- Matlab 4.0

These purchases and their installation continued the process of reallocating and merging the functions of several CRF computer systems into one system.

Appendix H

Delivery Order No. 8

Core Driven Fan Test Support

Core Driven Fan Test Support

In preparation for the Core Drive Fan (CDF) test, a Memorandum of Agreement was established with GE to define the operational environment, areas of responsibility, and the authority associated with remote observation and data processing during a classified operational period. Security plans for the CRF network and computer systems (VAX, ADA, Monitor, Control computers, and classified PC) were updated or generated. VAX training sessions were held to familiarize CRF and GE personnel with the on-line computer capabilities. Computer Operator training was provided and operator notes were updated.

Minimum manning test support was provided for the Computer Operator and Kulite/ Aeromechanics Engineer positions. Computer Operator responsibilities included classifying and declassifying the computer systems as well as controlling all media and output. Kulite/Aeromechanics responsibilities included observing the case-mounted Kulites during transients, acquiring high-response data (including over-the-rotor Kulite data), and making decisions regarding the general operation and accuracy of the Kulites.

CRF-GE Classified Network

Secure computer communications were established between the CRF and GE for use during testing. The CRF LAN was restructured for direct router access to the Area B fiber ring, and encryption equipment was researched, procured, and installed. Training on configuration, maintenance, operation, and auditing of the encryption devices was set up and held locally for GE, Air Force, and Battelle personnel.

Encryption keys were acquired, software updates were loaded, and communication tests were performed between the CRF and GE. Upon successful completion of the tests, configuration disks for the on-line tests were created and distributed.

TCP/IP communications were then established with a GE workstation that appeared as an Xterminal to the CRF on-line software. This allowed Test Article Graphics, Facility Graphics, compressor data displays, and help functions to be viewed at GE. Software was developed to FTP static, monitor, and transient data files to GE.

Scanivalve Digital Control

A digital control interface was purchased, installed, and tested. A Scanivalve database was designed, and initial communication with the Scanivalve controller was established.

Software was developed to control the Scanivalve system while taking static data points, integrate the Scanivalve data into the static data, and then record, process, and display the data.

Timing problems were encountered and resolved by adding a two-second delay after commanding the Scanivalve system to home and before checking to see if it is settled.

Presys 1000, Preston Data Acquisition Interface

Logical Company fiber optic modems were purchased to interface the Presys 1000 with the VAX. The modems were installed and the Presys was tested for 48 hours using an 800-foot fiber optic cable. Upon successful execution of the test, the Presys was returned to Preston to be fitted with a custom multiplexor.

After the Presys was returned, an Acceptance Test Plan (ATP) was successfully executed. The three ATP programs were then converted into Presys diagnostic programs. One program verifies the operation of the analog-to-digital converter, another program tests multiplexor addressing, and the remaining program verifies that the number of scans received per second is correct.

Two on-line tasks (to read data and allow the user to control data acquisition) were written to control the Presys and two screens were developed to control these tasks. One screen is used to take monitor, static, or transient data and to initiate a channel check or pressure calibration sequence. The other screen is used to display status information about the data acquisition, storage, and processing tasks.

Test Article Graphics

The Test Article Graphics software was modified to incorporate two new graph types: a scatter plot that associates multiple X-Y header pairs with a single marker type and allows multiple sets of X-Y pairs, and a strip chart showing multiple variables versus time.

A user interface was incorporated to allow previous standard format file reading numbers to be used as background data. The new interface requires less user time to specify reading numbers and provides easier input error identification.

A spline curve fit routine was added to enhance pressure ratio and efficiency versus mass flow plots. This allows additional points to be plotted between the background points.

The capability to allow users to plot any header versus any header was also added. This included storing information about the last plotted headers and axis scales so that they can be used as default values when multiple plots are made.

In addition, enhancements were made which sped up the generation of background lines for the compressor map by a factor of about 15.

A new type 10 Test Article Graphics plot was added to the graphics menu as requested by the users.

Channel Checks and PCALs

Test article control and data acquisition tasks were modified to incorporate Heise control, channel checks, displaying bad header data after a channel check, and saving the database information calculated during a channel check.

Test Article Playback software was modified to enable users to playback the PCAL static points and save desired database changes from playback.

Database Generator

The database generator was modified to incorporate a new file structure for digital data which included data from the Control computers, barometers, and the time code generator.

Critical Channel Download

Software was written to calculate the Control computer counts values for all critical channels. Engineering units are processed back through the data reduction software to determine the count values. The count values are then converted to the specifications for the Control computers and downloaded at the beginning of a test or on a user's command.

Barometers

A task was created to read data from the barometers once per minute and place it in the digital data database file structure. Cables were configured and communications were established with the barometers. A button was added to the Test Director/Engineers control screen to allow the barometers to be read on command and the display updating automatically.

Time Code Reader

Many problems occurred when the Presys tried to access the time code reader. These problems were caused by poor cabling, bad connections, and an inaccurate schematic diagram. All problems were resolved; software routines were generated and modified so that the time code reader could be tested.

On-line Operator Menu

A captive on-line account was established and a command procedure was written for the CRF Operator menu/account. An Xterminal serial port and terminal server were configured with the appropriate security provisions to provide access to this dedicated, non-passworded account.

The CRF Operator menu can be used to start the application software for a full facility run, a no-load run, or a tour. The menu also has options to create a software promotion tape, initialize a tape, reboot the system for unclassified testing, or shut down the system. When the system is classified, the menu includes a software promotion option. The menu and captive account were created to simplify the software startup process for operators and give the application software the capability to change its run-time priority.

Facility Database and Graphics Modifications

Facility database modifications were made as requested. Facility Graphics SV/SB screens were modified to match the CDF configuration, and an additional screen was created for the Core Inlet Guide Vane.

Screens 50 (Critical Channels) and 52 (CC Level Test) were removed and three new screens were added. Resulting views and software were checked for accuracy and utility. Facility Graphics Screens (located at the Test Director's Station) was updated with this new information.

The capability to add footnotes to Facility Graphics printouts was added.

On-line Campbell Diagrams

Phase one of the Campbell diagramming software implementation was completed. The software supports plotting of 1 channel to any Xterminal and acquisition of 28 channels to a Campbell data file that can be accessed by the Campbell plotting software. Plot files may then be converted from Meta files to PostScript files for printing.

Distortion Analysis Plotting

Standard format plotting software was modified to integrate Distortion Analysis Plotting. This included using data from a monitor reading number and modifying screens to allow users to search for different screen angles. Individual monitor reading number scans at the specified screen angles are then treated as static data points and sent to the preprocessor. Capabilities were added to the standard format file processing software to retrieve all delete codes (even those whose engineering values were deleted) for a distortion analysis run.

Transient Pressure Data Acquisition and Reduction; Over-the-Rotor (OTR) Kulites

On-line acquisition and reduction of analog pressure data was performed and the data was presented in an appropriate graphical format. The static pressure variations of 10 high-response (Kulite) and 10 steady-state (ZOC) pressure transducers across the fan tip were documented under several operating conditions. On-line software was developed to perform the analog-to-digital conversion and ensemble averaging of the Kulite data. On-line calibration procedures were developed to increase the over-all accuracy of the pressure measurements. A PC-based flow visualization software package was used to produce color contour plots showing static pressure variations through the fan tip.

Aeromechanics Station

Aeromechanical changes were added to current analog recording and monitoring procedures to ensure test article safety and facilitate economical data acquisition.

Aeromechanical forms were restructured and new forms were generated to simplify the on-line recording of test sequences.

To facilitate the playback process, analog tape log sheets were designed and printed for insertion into analog reel boxes.

Test Article Data Playback

Test Article Playback software was enhanced to allow static or monitor data to be printed. Classification format and print queue option problems were resolved. The capability to save database file structure modifications from playback session to playback session was also added.

Trouble Logs

Trouble Log -

Jumper out the AUX Air sequence from the Facility sequence.

The AUX AIR microsequence was removed from the Full Facility macrosequence.

Trouble Log -

Implement the capability to send data to ADA.

The on-line data reduction and playback software was modified to send data to the ADA system.

Trouble Log -

Allow headers to be acknowledged individually.

The on-line software was modified to allow headers to be acknowledged individually.

Trouble Log -

The Presys failed to respond on two occasions.

Powering the fiber optic modems off and on resolved the problem both times.

Trouble Log -

Problems were encountered during data transmission to GE.

GE had a disk failure.

Trouble Log -

An E-Stop occurred after receiving a "Monitor-VAX link failure" message.

All Test Article Graphics tasks had been set to a high priority and the link task could not get priority to run. A temporary script was written to reset all priorities without restarting the software. The problem could not be reproduced.

Trouble Log -

The surge light blinked and the black & white monitor displayed "SURGE" when no surge occurred.

The surge detect circuitry sent a false signal to TAC2 which caused the digital output to the surge lamp on Panel 3 to light and the "SURGE" message to appear on the black & whites. The problem was verified in Facility Playback. Wires were traced to the surge detect circuitry and the bypass surge detect circuit was disabled.

Trouble Log -

Presys in color graphics is always in alarm "Red."

Presys data updates were being time-stamped by two routines. One routine used the Presys clock; the other routine used the computer system clock. These two clocks were not synchronized and when the interval became excessive it was flagged as a failure by the software.

Time between updates had become 23 hours, 59 minutes, and 50 seconds when monitored every minute. Although the time interval was only a fraction of a second, it was considered to be off by almost an entire day. The software was modified so that only the computer system clock is used.

Trouble Log -

DO DECLASS failed.

Checking the print queue status caused the declassification procedure to abort. The declassification procedure was enhanced to be more tolerant of contingencies.

Trouble Log -

When turning on and/or rebooting Xterminals 1-9 and 13-20, Xterminals 1, 13, and 18-20 did not boot the first time. They had to be rebooted and/or turned off/on one or two times.

All Xterminals download simultaneously from the same computer during a test; therefore, some packets can become lost and occasionally a bad packet can be received. Xterminals store some of this data even when powered off so it may take more than one reboot to clear it. Temporarily, several reboots or power cycles should correct the problem. NCD issued a patch to correct the problem.

Trouble Log -

The static data points sent to GE on 26 July 94 were incomplete.

All data was retransmitted and verified by GE.

Trouble Log -

Mach number corrections were not applied to approximately 30 interstage temperatures due to typographical errors in the database. This affects all data prior to and including 21 July 94.

The database generator software was altered to flag misspelled headers. Software was then written and executed to correct the 27 affected headers. All previously taken static data was recalculated for the standard format file. A new standard format file was created with the new data and then transmitted to GE.

Trouble Log -

A better method is needed to request prints of Test Article Data System Reports.

Print buttons were added to the pressure calibration and channel check menus on the Test Article Data Control screen. The software was modified to send the reports to the laser printer.

Trouble Log -

Time and date stamp all reports.

Standard format file processing software was modified to add the date and time to the 11th data documentation record. This will allow the reports to be date and time stamped when the scan option is selected.

Trouble Log -

Several reading numbers are unreadable in the raw counts file used for static data points.

A backup of this file was obtained and most of the reading numbers were able to be processed.

Trouble Log -

Test Article Playback shows an "E" delete code for reading number 2616.

The "E" delete code was from an unused database file intended to store the number of headers that go into a deleted statistical header. The problem occurred when the Compressor Data Alphanumeric Display task used this database file structure but the Test Article Playback task did not and the number of test article data headers decreased. The Compressor Data Alphanumeric Display task was modified to use the appropriate database file structure.

Trouble Log -

Static data points are not being sent to GE.

GE was helped to resolve a problem that occurred because of an operating system in which security settings were not reinstalled. All static data points were transmitted.

Trouble Log -

The wrong correction headers were used to correct Venturi massflow for all data prior to 9 September 94.

Software was added to validate headers used for correction. The standard format file data was recalculated and transmitted to GE.

Trouble Log -

Reprocess reading number 2482, record intermediate calculations for static wire corrections, and provide information to GE.

The reading numbers were processed; intermediate temperature calculations for one header at each stage were written to a temporary data file, printed out, and then sent to GE.

Trouble Log -

TT00 headers are being auto-deleted and the actual values are completely different on Monitor data from 21 September through 28 September as compared to static data points.

A database name was misspelled in the software and has been corrected.

Trouble Log -

Bringing up a playback session and making on-line deletes causes a corruption of the delete code file structure.

This problem occurred when the software was configured to run on the Alpha and VS4 systems. It has been resolved and all software changes were properly documented.

Trouble Log -

When in the "Auto-Refresh" mode, clicking the 1/4 button drops you out of the plotting mode.

The problem was resolved.

Trouble Log -

If REFRESH is selected in Facility Plotting, the scales on the graph go to auto-scaling even though the Min & Max values for the Y parameters have been selected.

The Facility Plotting software was modified to correct this problem.

Trouble Log -

Power modem was lost and could not re-connect. Air Facility and Base CE still working okay.

The problem could not be repeated; however, precautions were taken to help ensure that it would not reoccur. Connections for the modem loop were rewired and secured, the mating connectors were rewired to eliminate the need for three gender changes, and various connections on the loop were tightened. The power monitor was then run for several hours without any errors.

Trouble Log -

The "confidential" flag is not reset after passing the 50% speed point. All Compressor Data Alphanumeric Displays go to confidential status and remain classified instead of returning to unclassified.

Software modifications were made to correct the problem.

Trouble Log -

While in blue playback and plotting several tangent record numbers from the September 14 run, the playback session went down.

The disk file containing static raw counts was corrupted. Static data for reading numbers 1 through 4931 must be processed from the playback tapes.

Trouble Log -

Health checklists taken at 15:57:34.35 and 21:10:31:22 are marked "confidential" when they should be marked "unclassified."

The problem could not be duplicated.

Trouble Log -

At the end of the test, the Test Operator entered a FIN command but the Monitor never got the message to run the DECLASS command, and the Event Logger never got the "Test Complete" message. Monitor was rebooted and CLEAR was run from batch.

The problem could not be reproduced.

Trouble Log -

RETRIEVE_DAP_DATA does not receive the proper values for the requested headers. This only happens on some of the reading numbers.

The indexes into the standard format file were not being calculated properly when delete code information was being retrieved. The software was modified and documentation was updated.

Trouble Log -

PWABC reads "no corrections" while there is a flow in by-pass.

The name of the humidity header was changed during the test. The software was modified to allow on-line changes.

Trouble Log -

The high-speed tape drive is not working properly and FCC1 is not communicating with the tape drive. Event Logging shows "HSDTAP?" However, the tape drive was running.

A loose cable was found and repaired.

Appendix I

Delivery Order No. 9

Fluid Dynamics Graphics Display

Computational Fluid Dynamics Upgrade

In support of the Compressor Research Facility's (CRF) Computational Fluid Dynamics effort, Battelle provided development efforts to maintain the readiness and enhance the capabilities of the CRF's embedded computer and instrumentation subsystems.

Under this Delivery Order, Battelle purchased the following items:

IRIS INDIGO ELAN Graphics (Monitor)

1.2 GB SCSI Option Disk, 3.5

IRIS Development Option (3.10 Back-End Based)

External CD-ROM SCSI Drive

FORTRAN 88 Compiler

Appendix J

Delivery Order No. 10

Functional Area / System Manager

Functional Area / System Manager

General system and network management duties were performed for all Compressor Research Facility (CRF) computer systems. Many hours were spent maintaining, troubleshooting, upgrading, updating, and tuning the systems and network as well as educating users. Time was also spent planning systems upgrades in preparation for upcoming tests.

Coordination was maintained with computer and network maintenance personnel to resolve problems, schedule preventative maintenance, and coordinate and communicate symptoms and solutions for various failures.

CRF computer functionality was modified to migrate the functions of the Main, DAC, and AUX computers to the VAX. This entailed removing the IBM-to-Modcomp links, replacing the TAC-to-DAC link with an RS-232 link between FCC1 and the VAX, and consolidating the Monitor software. The functionality of a number of user and system utility command procedures was also expanded.

New stand-alone backups were created; system backup routines are being revised to make them more functional in the changing environment of the CRF.

A Network General Sniffer was installed and configured to run on the CRF LAN. This device will be used to help diagnose network errors.

A display box that will show the classification status of the LAN and all computer systems in the Computer Room was designed and is being built.

The Critical Channel Alarm box was redesigned, rebuilt, and returned to operation.

A consolidated CRF PC software interface was researched for announcements, meeting notes, and trouble log submissions. The necessary web server and HTML (hypertext markup language) software was obtained and the test server is being installed.

Software was written to desensitize 4 mm tapes. This software will not declassify tapes but it can be used to erase sensitive unclassified data.

A QMS Magicolor Laser Printer was purchased and installed on the network. An additional capability using the printer for color copying is currently being researched.

A study was conducted on color scanners that could be used in the facility. Technical information and quotes were obtained.

Office Setup

The CRF purchased modular furniture for the office area of the Control Room. As part of this effort, Battelle was tasked to develop a network capable of providing connectivity to the new modules. This entailed creating floor layouts, designing the network layout, laying and testing the cables, and connecting PCs to the LAN. A bridge/repeater fiber optic link was installed between Building 71B floors to support PC connection to the CRF network. The feasibility of using a network hub to increase reliability and reduce the spares required for the CRF network was explored.

VAX Systems

Startup procedures were modified to allow terminal server reboots after power outages. Additional procedures were written to assist users in tracking Pathworks PC queues and file services as well as assist in creating and maintaining network disk and tape services. Problems with the ScriptServer print queue software were resolved.

NES management duties were performed and included ordering crypto keys to replace expired keys, replacing batteries, re-keying, and handling audit trails.

Software installation of VMS 6.1 on the VAX systems failed repeatedly and was traced to the SCSI bus drivers. DEC provided a patch and the VMS 6.1 operating system upgrade was then installed on all VAX systems. The VAXstation 3500s experienced severe disk problems during the initial operating system upgrade and the old operating system was restored. New removable disk systems were purchased and installed on the VAXstation 3500s and the new operating system was reloaded. The operating system upgrade affected practically all system level and layered software. Software suppliers provided appropriate upgrades/patches and layered software for all layered products was installed on all VAX systems. Problems were experienced when trying to compile and link the application software with the new compilers; several programs compiled with warnings and failed to link properly. Most of these problems were due to software variables used before they were initialized. All problems were resolved and the application software has been successfully compiled and linked.

The VS4 crashed during a thunderstorm. To save operational time, the system disk was restored from backups to a spare disk. A thorough examination and testing of the affected disk showed no permanent damage, but the disk software had to be totally restored from backups.

The VS4 disk subsystem and Qbus SCSI controller were mounted, and a VT520 terminal was purchased and installed for use as a console to three VAX systems.

A hardware error encountered on the VS4 disk chassis was resolved. Problems occurring on the VS4 unclassified disk packs were resolved, and the system was rebuilt from backups.

All online VMS disks were desensitized of any proprietary files that conflicted with the P&W Advanced Concepts Fan (ACF) test.

An intermittent system problem on the VAXstation 4000-200 is being researched in preparation for the installation of Pathworks server software and coordination is underway with the system vendor to solve licensing conflicts.

A method was established to access the Infoserver 4 mm DAT tape drive from any VMS system when running stand-alone backups. On some systems this will eliminate the need to use TK50 tapes and will result in considerable time savings.

The old 5 1/4" format disk subsystems on LAV and PPX were encountering multiple disk problems and were becoming increasingly expensive. These were replaced with new, more cost-effective 3 1/2" format disk subsystems. A classifiable network segment for LAV, an Xterminal, terminal server, and an NES link for secure communications were set up and the PPX network segment was restructured.

The year on VS4 was inadvertently changed to 1994 which resulted in multiple software problems due to the MAKE utilities that are used. These problems were resolved by resetting the year to 1995, deleting all object files and executables, and then recompiling and linking all the software.

The VMS queue startup was redesigned to consolidate queue information as well as simplify queue configuration and startup.

Alpha System

The VAX 6000 computer system was upgraded to an Alpha box. In support of this effort, the VAX 6000 was de-installed and prepared for removal from the facility. The Alpha hardware was then installed, SCSI cable connections were modified to standardize parts, and the operating system and software products were installed.

Compilation procedures were modified to use the new KAP preprocessors.

Software was written to obtain the size of a physical memory page necessary for converting the VAX software to run on the Alpha. All VS4 online application software was then ported to the Alpha and run in playback mode. A monitor data file was then transferred from VS4 and the online software was run. The results were successfully verified between the VS4 and Alpha. Two benchmarks (one using Test Article Graphics and the other using alphanumeric displays) were run. The software migration process as well as the benchmarks and their results were documented.

The CAMAC Serial Highway Driver crate and drivers were installed, fiber optic jumpers were routed, and a quote was obtained for the fiber optic jumpers needed to connect the CAMAC crates in the

Signal Conditioning Room. These jumpers were obtained and installed. Initial problems encountered with the SCSI controller were corrected. After the interduct and fiber optic cables needed for CAMAC communications were installed in the Signal Conditioning Room, initial testing of the link was performed.

Analog Data Analysis (ADA)

A security analysis was performed on the ADA Masscomp and the new Wright Laboratory computer banner was added to the login prompt to inform users that it is a government machine.

Two additional disk drives were purchased, formatted, partitioned, and installed to complement the capacity provided by the two existing drives. The drives were partitioned for the strain gage data processing/analysis software and the Kulite data processing and analysis software. The new drives also provide the capability to have an online system and data disk for both classified and unclassified processing. Multiple problems were encountered and solved during the installation process.

The capability to print multiple Campbell diagrams was provided. A short-term solution was implemented which entailed temporarily attaching a printer to the Masscomp and configuring it to print these files.

Disk drives released from the Turbine Research Facility's SUN were installed and tested on the ADA system to ensure compatibility. These drives tested successfully and are fully compatible with the ADA system.

An 8 mm 5 Gb Exabyte tape backup unit was installed on ADA to replace the 150 Mb cartridge tape backup unit. This will standardize the storage media used in the CRF and eliminate the old cartridge technology. The software device driver necessary to operate the unit has been located and ordered.

Analog Tape Digitizing System (ATDS)

Multiple UNIX kernels were generated to allow the machine to run in networked or non-networked mode. This was required to execute the Campbell diagram software.

A disk controller failed causing ATDS to crash and bad data to be written to the disk. The controller was replaced and a backup tape was used to restore the system and data. A board used to speed up the drive controller was suspected of being the actual cause of the problem; it was removed to prevent additional problems with the system.

Computational Fluid Dynamics 1 (CFD1)

A Silicon Graphics computer was purchased to run computational fluid dynamics programs. The computer was received and configured. User accounts were established.

Removable disk subsystems and 4 mm tape drives were researched for use on CFD1. Compatibility and redundancy between tape drives on the various CRF systems was a major consideration for the 4 mm tape drives. Quotes were obtained for removable disk subsystems and tape backup units. All equipment has been ordered.

CRF Input/Output (I/O) Systems

The DAC IOIS was removed making two 19" cabinets available for the new CAMAC I/O equipment.

The initial setup of the CAMAC I/O system was begun to replace the present Modcomp I/O system. The new material was uncrated and logged; two CAMAC crates were installed in the position of the old DAC IOIS. The warranty and registration information was sent to the manufacturer, and a list of additional equipment needs was generated.

Modcomp

The year was updated on all Modcomp computer systems and an inventory was made of available spare disks.

The Control computer upgrade plan continued to be enhanced. This entailed compiling and documenting the major tasks performed by the systems as well as any potential risks that could be foreseen. Various options for the re-design of shared memory logic and the operator interface were reviewed. PLC communication subroutines were converted to VMS and then tested.

Time Code Generator problems were traced to a wire that was tied into the ground in the Presys I/O cabinet. The lead was appropriately connected and the Time Code Generator problems disappeared.

PCs

General system management duties were performed for all CRF PCs. Many hours were spent maintaining, troubleshooting, and upgrading hardware and software packages as well as educating PC users. Hardware problems included replacing motherboards, disk drives, and monitors. User support was provided to answer questions related to the word processing, spreadsheet, and database packages as well as resolve memory management, network access, and file transfer problems.

PC configurations were reviewed and verified. A "template" PC configuration was generated to save setup time and ensure that new PCs conform to the standard CRF configuration. A standard software distribution for PCs was also developed to ensure that all systems have the same software configuration loaded.

More than 20 PCs were configured for use in the facility. Some of these PCs replaced older systems which were then upgraded (CPU and/or memory) and returned to service at the CRF. Significant cost savings were achieved by upgrading these machines. Two of these PCs were provided to run the software for the HAZMAT program. One of these systems was configured to support the Computer Maintenance Management System. Another PC was configured for classified processing. Classified procedures for this PC were implemented and a security plan was written and submitted for approval.

Due to staff relocations caused by the construction and installation of the new office modules, many PCs had to be reconfigured to retain access to the CRF network. These tasks were performed as needed.

PC network startup files were upgraded to allow "automatic" upgrades to the individual PCs. A "CRF" service was set up to ease the exchange of files within the CRF. A service was created for the various CRF-wide databases and simple icon connection procedures were set up for all file and printer services. Network cards to support connectivity to the UTP network were installed.

Windows for Workgroups was installed on a PC to test and evaluate connectivity with Windows NT and DEC Pathworks servers. The migration to Windows for Workgroups and Windows NT will provide the CRF network with enhanced functionality to access additional network services.

A cost study was conducted to evaluate purchasing new PCs versus upgrading currently owned 386 systems. It was determined that it would be more cost-effective to upgrade the machines. A local vendor has been contacted.

Monitor IOIS

Monitor IOIS problems were experienced. Various boards were swapped (replacing Control Logics and changing the external interrupt coupler); reseating all the cards resolved the problem. A spare Control Logic card is being configured to maintain system readiness.

Network

Battelle was tasked to expand the CRF network to include Buildings 71B, 71D, J-Bay, 20, 20A, and 21. Several vendors were contacted to bid on the installation of fiber optic cables necessary for computer communications between buildings. Quotes were obtained and a purchase order was issued.

The possibility of using modular repeaters in the fiber optic network expansion was researched and a modular unit was purchased. This unit will assist in accommodating configuration changes such as the addition or removal of devices. It will also reduce the number of spares required for the CRF network. LAN closets to be used at remote locations were researched and quotes were obtained.

The UTP network installation in Building 71B, Room 243, was completed. This included testing cables, diagnosing and correcting cable plant problems, and connecting users when the installation was complete.

Data Acquisition PC Study And The Stall Avoidance System

Several seminars were attended to identify hardware and software necessary to build a PC-based data acquisition system. Although the necessary hardware and software (e.g., LABVIEW) have been obtained, testing has been delayed due to ACF test requirements. The stall data obtained during the ACF test will be used for the stall avoidance system project.

Software Enhancements/Updates

<u>Calibration Data File</u>

A new calibration data file was created and appropriate software was modified to write all channel check, pressure calibration, ZAD, and Kulite data to it. In this way, the raw counts static data file will remain on the disk for the entire compressor test thus speeding up the end-of-day backup process.

<u>Facility Historical Playback</u>

The Facility Historical Playback software was modified to update the facility historical files every 10 seconds instead of only when the software is shut down. This will prevent facility historical data loss if the software is aborted before the files have been updated and closed properly.

<u>FCC1 High-Speed Data Tape</u>

The High-Speed Data Tape software was modified to start on the second microsequence (12.4 Motor Ventilation) rather than the third (12,400 hp Motor). This will prevent the 12.4 motor from tripping due to tape drive problems. Additional checks were added for busy/incomplete error conditions.

Test Article Data

The Test Article Data Raw Counts Storage and Test Article Data Control software was modified to perform better integrity checks of the raw counts data files when the software is started. These integrity checks test for a wider range of possible data problems. At software startup, information screens for Test Article Data Control will provide a status report on the raw counts files.

Test Article Data Playback

Software modifications were made to automatically load performance constants at startup and when playback is executed. In the past, performance constant changes were entered manually.

Miscellaneous Software Changes

Software was written to download the critical channel and test article peculiar databases from the VAX to FCC1.

Software was also written to control channel check and PCAL digital inputs and outputs through an IOTech. A reliability problem was corrected by changing the wiring of the RS-232 cable.

Software checkout and promotion procedures were modified to reflect the removal of V6.

When exhaustive testing was performed on the VAX online software to fine-tune its operation, it was noted that CPU usage dropped from 90% to 50% when the number of scans displayed on the screen was decreased from 1 every 2 seconds to 1 every 3 seconds. The software was modified so that the reduction task now processes only one scan of data every three seconds. As a result, the response time of other tasks increased thus allowing data to be processed at a faster rate.

An error which caused the reduction process to abort was found in the Engineering Units Conversion software and was resolved.

An error which caused the Facility Playback software to abort was researched and resolved. Other software routines were modified to prevent future errors.

The priority of various software modules was modified so that the data acquisition and storage tasks had higher priority than the display and reduction tasks. This was done because of the importance of gathering and storing the data relative to displaying and reducing it.

Software modifications were made to eliminate compiler warnings and to correct an error that occurred when accessing the Facility Graphics power monitoring screen.

Help Screens

The VAX Help screens were reviewed for standardization (screen color, button text, etc.), use (button position, missing buttons, etc.), and text inconsistencies. Corrections were made.

Reduction Of ADLARF Laser Doppler Velocimetry (LDV) Data

Software previously written to reduce ADLARF LDV data was modified to create data files usable by Tecplot. Updating the LDV software to run in a new system environment using updated graphics was also required. The software is nearly operational, but completion of ADLARF related projects is a low priority at this time.

Navy Energy Absorber Test (NEAT)

Modcomp database modifications were made to accommodate the NEAT test. At the completion of the test, sensitive data files were removed and microsequence modifications were made to remove all test-specific software changes.

Directory Reorganization

The disk directory structures were modified to support future CRF tests. This reorganization frees disk space for test article data and allows the use of a third disk. Coding changes were made to use the new logical names in the test article and facility data system software.

Documentation

Documentation was updated or created as necessary. This included facility functional documentation, online documentation, online help information, user's guides, user information, facility and security policies, and operator and programmers notes.

Color Printer/Plotter

The possibility of upgrading the old Calcomp ColorMaster color printers for use by network PC users was considered and rejected due to the upgrade cost and age of the equipment. A new color printer was selected and purchased. The option of using the new printer with a color scanner to perform color printing is being researched.

ADPE Turn In

Surplus ADPE materials were prepared for removal. Items were inventoried, swapped, re-directed, or moved out.

Trouble Logs

Trouble Log -

Make critical channels functional for the Navy test.

To make these channels functional for the Navy test, some of the channels had to be limit checked even during the Noload. Software was modified to allow FCCDAT subscripts in the range of the critical channels. Several channels required an offset as well as a scale factor. In these cases, the alarm limits were expressed in counts instead of engineering units. Temporary code was added to create new headers. This code will be deleted at the end of the Navy test.

Trouble Log -

Implement test article peculiar parameters for Navy Water Break Test.

Changes were implemented as required.

Trouble Log -

When the Control computers are rebooted, the 12.4 trips offline.

The software contained logic to E-Stop if 10 seconds passed without a message from the Monitor indicating that it sent data successfully to the VAX. This caused an E-Stop as soon as the Control computers were started. No event log message displayed because panel 2 was not armed.

The software was modified to bypass the E-Stop if panel 2 is disarmed or if it is armed and the current microsequence is the 12.4 (in case the 12.4 macrosequence is completed and left with the panel armed).

Trouble Log -

An E-Trip occurred due to FCCDAT 752 and 754 not meeting the minimum flow requirements of 150 GPM total flow. Looking at the Facility Graphics, the combined flow never dropped below 250 GPM.

The calibration coefficients were corrected and the limit-check database was modified to match the coefficients used in the Facility Graphics.

Trouble Log -

Change minimum speed to 2215. It currently goes to 3541 rpm. The change is required because the Low Speed Motor will be used for the Navy Energy Absorber Test (NEAT).

The minimum speed command was changed as requested. Software was modified as appropriate.

Trouble Log -

Need a new screen for new header types.

Screen 7 (Energy Absorption Test) was developed for Facility Graphics. Software was modified to add new header types which multiply by slope and add offset. Several headers for the Navy test required this calculation type.

Trouble Log -

Change gearbox vibration limits as noted.

Database changes were made and documented. A full database printout was generated.

Trouble Log -

At minimum speed the mechanical speed read -2215 and gearbox speed read -29.6. They should have read -443.0.

This problem was traced to a calculation in which drive speed rather than test article speed was used. The calculation was corrected and tested satisfactorily in playback.

Trouble Log -

Facility data variable 788 was plotted from 16:24:31 to 23:01:57 and the max temperature on the plot was less than 95 degrees F. Even after shutdown the temperature was greater than 115 degrees F.

This new variable has a slope and offset associated with it. The graphics were changed to accommodate this; however, plotting wasn't. The plotted values were skewed from the displayed value by the offset. The plotting software was changed to accept the offset and all modifications were tested through playback.

Trouble Log -

Screen 16 (DC Loop Breaker); Vacuum Pump #1 shows PLC bit 04200. Should be 04201.

This was a problem only with the display. The database generator stores the last value used for index and bit position; it was the 3-pump summary bit in this case. The database was rearranged to provide a more accurate display.

Trouble Log -

Add an automatic refreshing feature to Facility Plotting so the X-Y plotting will automatically refresh itself if requested. A variable refresh period is desirable; however, if a fixed period is required, 5 seconds should suffice.

A variable refresh period from 2.0 to 300.0 seconds was added to Facility Plotting. The default value is 5.0 seconds.

Trouble Log -

Modify the Facility Plotting capabilities to allow header vs. header plotting.

Facility Plotting was modified to allow this change. This feature can be selected from the Main Menu by selecting Plotting in the Facility Data System section.

Trouble Log -

The capability does not exist to create an ASCII file from facility historical data. System should be able to print at least 8 channels in addition to time for facility historical data over a specified period of time.

The Facility Plotting software was modified to allow up to 16 channels of input/output. As in the original system, headers may be entered by header name, FCCDAT word, FCCDAT word and bit, or PLC octal address.

The Main Facility Plotting View has a new box entitled ASCII at the lower left corner. Press this button after entering a valid file name and valid time period. The user can enter up to four headers.

The ASCII File View has openings for 16 total headers. If four are entered, these four will be shown on the ASCII view. Writing of headers may be disabled/enabled by clicking the corresponding box at the bottom of the view.

Trouble Log -

Jumper out the AUX Air sequence from the facility sequence until further notice.

The AUX Air microsequence was removed from the Full Facility macrosequence. Software was modified as required. A copy of the new macro/micro sequence chart was placed at the Facility Engineer's Station.

Trouble Log -

Add a feature to Facility Plotting so that footnotes can be added to data printouts.

A feature was added to Facility Plotting so that footnotes can be added to data printouts. This feature can be used by using different mouse buttons.

- If the PRINT button is selected with the left mouse button, the plot and any data points which have been selected will be printed.
- If the PRINT button is selected with the middle mouse button, the user can enter a message up to 60 characters which will be inserted at the bottom of the plot. The plot and any data points which have been selected will be printed.
- If the PRINT button is selected with the right mouse button, the user can enter a message up to 800 characters which will be printed separately from the plot. This message will appear

beneath the selected data points if there have been data points selected. The message may be used to explain the reasons why data points were selected and can help explain trouble logs or other correspondence.

Trouble Log -

Need a better way to print out the Data Engineer reports.

The capability to send Data Engineer reports to the printer was simplified by adding report print buttons that can be selected with a mouse.

Trouble Log -

Need PERCH installed on the VAX.

PERCH was installed on the VAX. A compile and link procedure was written for this software, and various routines were concatenated. Documentation was generated.

Trouble Log -

Screen 13 (SV/SB Control) keeps going into Speed Control Loop alarm right before synching into minimum speed.

Through playback the problem was observed 5 times during the run of 18May94. A significant speed transient preceded each occurrence of the alarm condition. Another significant observation is that the two tachometer feedbacks are unstable in the vicinity of each of the fault conditions. It is possible that the disparity in the two feedbacks is the cause of the fault condition.

Suggestions include:

- Continue with the present condition. Although this is a Speed Control Alarm, it is only a microsequence (test article control) warning condition and won't stop the test. It may resolve itself without any action.
- Adjust the delta time or delta speed for transient faults. Increase either to eradicate the fault.
- Adjust the Speed Trim Rate. (This is unlikely to have much effect.)
- Adjust the delta time for the fault condition which keys upon the disparity between the TAC1 and TAC2 tachometer readings.

Trouble Log -

Allow any header versus any header to be plotted in Test Article Graphics.

The Test Article Graphics software was modified to add the option of plotting any header versus any header. This included storing information about the last headers plotted and the last axis scales used so that when multiple plots are made, most of the previous answers to questions that the software asks of the user are presented as the default answer the next time through the software. Software was cleaned up and modularized. The routines which drew the background lines for the compressor map were modified to speed them up. The new code required more memory than the old, but sped up background data drawing by a factor of about 15.

Trouble Log -

Resolve limit-check problems.

Limit-check problems were resolved and the capability to individually acknowledge test article headers was added.

Trouble Log -

Static prints are not being labeled properly. The unclassified and classified labels are not at the top and bottom of each page. Also, when one static print is requested, three are printed out on the printer. Note: This problem does not occur when a user runs MCP out of his library.

A header was placed on the printout when the software was started from a user's ID and not when started from CRFOPR because the printouts go into different queues. The problem was resolved by forcing a header.

Trouble Log -

The 12.4 khp motor tripped off-line twice when the Air Facility in Building 18 started Centac #1. It appears Exciter E-1 sees a "low line" input and shuts off. Graph all 12.4 khp motor parameters on the high-speed data tape for 23Jun94, approximately 2035 when the last trip occurred.

The 23Jun94 high-speed data tape included data from 16:24:24.966 until 20:20:22.490. The time requested was not on the tape. At the final scan the test termination code was zero which indicated that a stop had not yet occurred. The data presently on tape does not include any 12.4 khp motor parameters.

The 12.4 khp parameters can be added to the high-speed data but a decision must be made concerning which data it will replace.

Trouble Log -

During distortion runs monitor data needs to be acquired during the 360 degree screen rotations converted to steady state data format for use by the DAP data retrieval subroutine. The ability to select individual scans the same way reading numbers are selected needs to be implemented.

The software was modified to extract data from a monitor reading number for a distortion run, allowing users to search for up to 20 angles. The software searches the reading number for the angles and treats a single scan of monitor data at the right angle as a static. Documentation was updated.

Trouble Log -

Add the following delete codes to the list of choices:

X - not repairable

L - PCAL delete

M - ZAD delete

The software was modified to allow for the new delete codes. Code changes were documented.

Trouble Log -

Both nozzle calculations are reading on the order of 30,000 which is carrying over into other flow calculations. Orifice calculations are reading "NOSTA56." Upstream statics on bore in are both deleted so there is no "PD" calculation.

The proper error flag was not being passed. This was corrected and code changes were documented.

Trouble Log -

The Orifice calculations are returning a +30266 when the PDV value is negative. The value of Orifice output should be -30,000 or more, then a flag would be set and the flow rate would be "NO PRO." With the flow being set to +30,000 this flow value is returned as a real number and used in other calculations. The TISNOZZLE program should also be reviewed although it seems to be working properly.

Code in TIS*xxx* routines was not checking for delete codes or error conditions properly. This was corrected and code changes were documented.

<u>Trouble Log -</u>

User-defined CDAND displays are not going classified above 50% speed. Alphanumeric displays are working properly.

PNC2C was not being calculated properly. Since the CDAND displays key on PNC2C, the user-defined displays did not respond correctly. This problem was corrected.

<u>Trouble Log -</u>

Delete code FS length has been corrupted. The file may have been corrupted by performing a PCAL and deleting a header at the same time.

The database files were restored and extra checks were incorporated into the software to detect a corrupted database file in memory before it is written to disk. Code changes were documented.

<u>Trouble Log -</u>

19" mass flow reads too high. 12 1/2" mass flow reads too low. These calculations need to be checked out.

The 19" and 12" Venturi were switched in the database. The database input was changed and the generator was run.

<u>Trouble Log -</u>

Facility Graphics "Header Bar" does not have numbers for Screens 50 and 51 showing.

Prior to the CDF test, the Facility Graphics changes included the omission of the Test Director's screens (50 and 51). A trouble log must be submitted if these are to be added back into the graphics system.

Trouble Log -

Put Fuller into facility sequence. (AUX Air sequence must be returned to Facility Graphics.)

This change was done as a temporary fix so that the facility could run and then backed out due to problems encountered in the Fuller/AUX Air sequence. It has not been reinstated.

Trouble Log -

The PCAL software does not reset after an abort. Test Article Data Reduction should be stopped and restarted after an abort.

The Test Article Data Reduction software was modified to allow it to be stopped and restarted when an aborted PCAL is seen. When MCP receives a message code indicating that PCAL has aborted, it waits two seconds and then restarts the reduction software. All software changes were documented as appropriate.

Trouble Log -

Problems with a disabled black & white were solved.

Trouble Log -

The capability to perform automatic ZOC and Druck (ZAD) calibration checks needs to be implemented on VS4.

The ZAD capability was implemented on VS4.

Several new software modules were designed and many existing modules were modified. All software changes were documented, help screens were generated, and functional documentation is being written.

ZAD and KULITE buttons were added to the Test Article Data Control Display. The ability to abort a Kulite or ZAD was implemented so that the procedure could be terminated at any point by pressing the STOP button. This turns off the Nitrogen and stops communications with the Heise controllers.

Trouble Log -

Change high-speed facility data tape variables as required.

Software modifications were required on PPX, FCC1, and FCC2.

The FCC1 high-speed data tape routine was modified to add Sub C output voltage, Exciter 1 Output Current, and Exciter 1 Output Voltage. These replaced the Frequency Converter Setpoint, the backup DC Loop current, and the Vars reading on the Drive Motors.

The FCC2 data input routine was modified to add Sub C voltage and Exciter 1 Voltage to "fast data" channels. These replaced E06VAR3 and E06A5BU. Exciter 1 Current was already read as a fast channel.

High-speed plotting and variable routines were modified on PPX. A 30-character descriptive field was created and new headers were added.

Trouble Log -

Problems exist with the Power Monitoring screen:

a) Header is red when peak is predicted to be exceeded. Should be yellow?

b) Reset Base Peak MTD from 73.5 to 75.2. Red line seems to be ratchet number 62.5.

c) Screen thinks numbers like 67.5 are warning (yellow). Don't know why.

All problems were resolved. The software was checked and documentation was generated.

Trouble Log -

Create Facility Graphics screens to support the Sectored IGV Test.

Facility Graphics SV/SB Core IGV Control and SV/SB Channels 6-8 screens were created.

Trouble Log -

On SV/SB Core IGV Control screen, sector 2, 3, and 4 do not follow the schedule.

The screen wasn't complete. It is now finished and works as expected.

Trouble Log -

Print out PLC I/O table from Facility Historical Data for the second preceding, the second of, and the second after the E-Stop of 14 September 94.

Printouts were provided as requested. The PLC I/O tables were included. The times printed were 19:58:58.972; 19:59:00.106; and 19:59:01.032. There were no PLC changes; PLC1 saw no changes during the E-Stop.

Trouble Log -

Update the IGV schedule on SV/SB Control and SV/SB Core IGV Control screens (yellow line) using the required setpoints.

Changes were made as requested.

Trouble Log -

Add a button at the bottom of the screen to allow users to switch the display to mVs which is similar to the buttons used to switch to counts, engineering units, and corrected engineering units. This will facilitate trouble-shooting and end-to-ends by allowing a page of mVs instead of having to page through individual displays for mVs.

The Compressor Data Alphanumeric Display software was modified to allow data to be displayed in the millivolts database file structure. Using the right-most mouse button to click the CDAND button labeled "UNC" causes the button text to change to "MVT" and the display to show millivolts. All software and screens were updated and documented as appropriate.

Appendix K

Delivery Order No. 11

Data Acquisition and Analysis Enhancement

Data Acquisition and Analysis Enhancement

In support of the Compressor Research Facility computer upgrade, Battelle provided development, modification, and redesign efforts to maintain the readiness and enhance the capabilities of the embedded computer and instrumentation subsystems.

Under this Delivery Order, Battelle purchased the following items to continue the implementation of the computer replacement.

- ORIFICE2 - Flow Conditioning Software
- Mwave Developers Toolkit with Windsurfer for Acoustic Data Analysis
- Aeromechanics Station Video Printer and Copier
- MATLAB 4.0
- Alpha5 1.0
- 48-Bit TTL PTO Board with I/O Buffers, Handshake and Interrupts
- 21" Color Monitor for Classified PC
- Disk Subsystems:
    - 2.1 GB Disk Drive and Hot Plug Carrier (LAV and PPX)
    - 2.9 GB Disk in Plastic Canister
    - 4.3 GB Disk, 2.1 GB Disk, and 4.0 GB Disk for NT Server
- DataViews Maintenance
- QMS Magicolor Laser Printer and Supplies
- Windows NT Advanced Server 3.5
- WinDD Server
- Kinetics Data Acquisition Hardware:
    - 32-Channel, 16-Bit Scan A/D Converter
    - Dual 16-Channel Rack Terminal Panel
    - Module I/O Cable
    - Rack Termination Panel
- Network Components:
    - Transceivers and Cables

Terminal Server and Print Server

Switching Network

NES Encryption Equipment Extended Hot-Line Support

16-Line Terminal Print Server

These purchases and their installation continued the process of reallocating and merging the functions of several CRF computer systems into one system.

Appendix L

Delivery Order No. 12

ADLARF and CDF Data Reduction

ADLARF and CDF Data Reduction

Strain Gage Data Acquisition and Analysis Software

Enhancements were made to the Masscomp strain gage data acquisition and analysis software to utilize the i860 processor as a separate computing environment. This will allow Campbell data to be compressed during acquisition which will drastically reduce the file sizes and speed data access. In the future, the capability to display multiple channels of Campbell data in real time will be added.

Acoustic Data Analysis

During Core Drive Fan (CDF) testing, it was discovered that an audible signature occurs whenever a compressor stalls or surges. To research this phenomenon, a PC was configured with CD-ROM and C/C++ to investigate the possibility of detecting stalls from acoustic data. A multimedia digital signal processing (DSP) board was then purchased and installed in the PC. This board will allow analog-to-digital data to be acquired, processed, and then output to a digital-to-analog converter. DSP software will be developed on the PC and downloaded to the DSP board. In addition, MATLAB was installed to allow spectrum analysis functions such as traditional Fourier based methods as well as Yule-Walker based statistical signal processing methods to be used for acoustic data analysis.

Stall Analysis Paper

An abstract for the paper entitled A Comparison of Power Spectrum Estimation Methods for Detection of Compressor Stall has been submitted for Air Force release approval. This paper will discuss the use of Yule-Walker based MATLAB functions to provide better stall warning than Fourier based methods.

Tape Recorder Problems

After discussing with Data Tape the tape recorder problems encountered with tape deck incompatibility, it was determined that the tape deck recording heads have sufficient error to cause tapes from different decks to be incompatible. A tape switching network to alleviate some of the playback problems and eliminate the need for patching whenever a tape will be played back on a different deck was researched. Quotations were obtained and submitted to the Air Force.

ASME Paper

The Measurement and Prediction of the Tip Flow Field in a Transonic Low Aspect Ratio Compressor ASME paper presents details about the tip flow field behavior in a low aspect ratio fan and uses data obtained during the Advanced Damping Low Aspect Ratio Fans (ADLARF) test. This paper will be presented at the 40th ASME International Gas Turbine & Aeroengine Congress/Users Symposium and Exposition in June of next year. It was written in conjunction with the US Air Force.

AIAA Papers

Two AIAA papers were developed in conjunction with the US Air Force and will be presented at the 31st AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit that will be held next year.

The Baseline Performance of a Full-Scale Low Aspect Ratio Transonic Compressor paper uses Laser Doppler Velocimetry (LDV) data acquired during the ADLARF test to discuss flow field behavior.

The Influence of Inlet Distortion on Transonic Compressor Blade Loading paper presents details about the blade mounted pressure transducer data acquired during the ADLARF test to determine transient forces and moments on a fan blade.

Project Reports

Two reports were completed and are pending public release.

The Acquisition and Reduction of Blade Mounted Pressure Transducer Data report presents the methodology by which unsteady blade forces and momentum can be determined using blade-mounted pressure transducer data. The transducer data was also used to show how inlet distortions and resulting unsteady forces affect the blade resonance of high-speed fans.

The Acquisition and Reduction of Rotor Tip Static Pressure Transducer Data From a Low Aspect Ratio Fan report presents the process and problems associated with the acquisition and reduction of over-the-rotor data and demonstrates the ability to reduce, display, and analyze static pressure data acquired from fan and compressor tip regions.

Transient Pressure Data Acquisition and Reduction for the CDF Test Over-the-Rotor Kulites

Online data acquisition was used to acquire data for several different operating conditions. Twenty-six data points were acquired before the bypass fan in the CDF rig failed and the project was terminated.

Reduction of ADLARF Laser Doppler Velocimetry (LDV) Data

ADLARF LDV data reduction software was modified to create data files that can be accessed by Tecplot and used in several papers.

Trouble Logs

Trouble Log -

Digitization of ADLARF stall inception data was requested in support of a joint research effort with the Michigan Institute of Technology (MIT).

Data was digitized for 68%, 85%, and 98.6% speed; nominal vane settings; and all three casing treatments.

Trouble Log -

Playback in the form of digitized data was requested for the combustor and bypass Kulites for two different stall events during the CDF test (Stalls 46 and 47) which occurred during R#'s 3632 and 3635, respectively.

Twenty Kulite signals for both stall events were digitized using Laboratory Work Bench. The data was calibrated and processed into a format acceptable to Tecplot and then it was plotted and printed. The raw digitized data and the Tecplot data files are available upon request; the data plots and a brief information sheet and analysis were provided to the trouble log initiator.

Appendix M

Delivery Order No. 13

Advanced Concepts Fan Support

Advanced Concepts Fan Support

All work performed under this delivery order was properly documented and included software updates (header and internal code), CRF functional documentation (new and updated), and trouble logs (problem reiteration and detailed solutions).

Three 2.9 and two 2.1 GB disk drives and a TCP/IP license were purchased to support the Advanced Concepts Fan test.

Secure communications were established with P&W to allow on-line test monitoring from Florida. A security memorandum of agreement was generated between P&W and the Air Force, NES encryption equipment was configured, and on-line data transfer was established. Training was provided to P&W personnel on the use of CRF on-line options and data transmission.

Classified disks were built for VS4, ADA, Monitor, LAV, and the PC. System user accounts were established, and application libraries were built.

Security documentation was updated as required.

P&W Universal Data Format File

Software provided by P&W to place test article data in their "Universal Data Format" was loaded, compiled, and executed. All related problems were resolved and a Universal Data Format file was generated and transmitted to P&W. A security screen was developed to request a user ID and password before allowing access to the P&W computer system.

Minimum Manning Test Support

Minimum manning test support was provided for the Computer Operator and Kulite / Aeromechanics Engineer positions.

Software Engineer responsibilities included:

- bringing the computers and links up in classified mode
- establishing links between the various computers (VS4, Monitor, and ADA)
- activating the NES encryption equipment for communication with P&W and the laser system
- entering the P&W password and ensuring that data transferred correctly
- starting the application software on VS4 and the Monitor

- troubleshooting computer and link-related problems as they occurred
- assisting users with problems, logging printouts, and running backup jobs at the end of the test
- logging software changes and declassifying computers, Xterminals, and printers
- bringing up the systems in unclassified mode after the declassification process was completed
- transmitting data to P&W

Kulite Aeromechanics Engineer responsibilities included:

- monitoring transducer signals to identify transients (e.g., stall)
- supporting the Aeromechanics Engineer on data processing issues
- monitoring recorded signals to verify data integrity
- processing over-the-rotor Kulite data

Laser Data Acquisition

Communications were established between the VAX on-line system and LAV. Fifty-four headers were added to the test article database to allow laser data to be monitored on Xterminals during the laser portion of the test.

LAV control software was developed for the new traversing system, and blade geometry files were translated into a format usable by the Laser Doppler Velocimeter software. The data acquisition algorithms were reviewed and software was written to plot the velocity and the Mach number in the blade tip region. The test matrices' algorithms were researched to obtain a better understanding of the use of the angle of the laser relative to the test article in reducing the laser data.

Technical support for laser system calibration, alignment, and general maintenance was performed.

Over-the-Rotor Kulite Data Acquisition

A Masscomp system was configured and software was loaded to acquire over-the-rotor Kulite data. Analysis software was loaded on the classified PC, and software was written to send the data from the Masscomp to the PC.

VAX On-line Data Acquisition and Analysis Enhancements

Software modifications were made to meet test article specific requirements and to enhance existing capabilities. Database download software was modified to facilitate sending databases from the on-line VAX to the Control computers without a request from the Control computers. The time and date were added to calibration reports, critical channel problems related to channels not being defined correctly were resolved, and a new method of calculating humidity was implemented to increase its accuracy. Valve schedules and limit curves were updated to reflect changes to the actual schedules.

Test Article Database Updates

Four new statistical headers were added for calculations on the Rotor 2 casing treatment; type 28 header problems related to static data not transferring the correct number of constants were resolved; type 25 measurement headers were updated to allow modification of A, B, and C coefficients and deviation constants on-line; and two new flow rate statistical types were added to the test article data reduction and playback software.

Test Article Display Updates

The number of Xterminal windows displayable simultaneously was reduced to six to ensure that system timing would not be affected, background maps on XT01 were updated (%PR vs %Flow and %ETA vs %Flow) by re-mapping the view files, compressor data alphanumeric tasks were modified to write the test article data constants database to a user-specified directory, new test article data control screens were developed, and software was modified to remove the Scanivalve option. The ability to view the classification of individual headers, as defined in the database, was implemented to allow users to determine which header caused the screen to become classified and to aid in debugging.

Facility Graphic Updates

Facility color graphics modifications were made to add a third SV/SB feedback on the SV/SB screens and to disable the FC Drive Start and SV/SB Channels screens. The critical channel level test screen was deactivated, the 100% design speed was changed, and the number of critical channels was revised.

Standard Format File

Hardware channels had inadvertently been switched on the test article thus affecting the data for the entire test. Temporary software changes were made in the data reduction software to switch the values for these headers during playback before creating the final standard format file.

A new graphical user interface for standard format plotting was developed to allow a user to enter the name of the file containing the header names to scan for and a destination filename to which the results can be written. Options to automatically print the file and label the top and bottom of a printout with a "confidential" label were also added.

System Problems

The Monitor computer halted without warning thus breaking the link to the on-line VAX and Control computers. Previously, the Monitor had a cold start problem and four boards were swapped, but this modification had not been documented. Maintenance personnel were contacted to resolve the link problem which was eventually traced to one of the new boards. The old boards were reinstalled and the system tested successfully. A new maintenance form was generated and will be used to document any service that is performed on any system. Completed forms will help troubleshoot future system problems.

Control Computer Updates

Modifications were made to enhance the operation of the microsequences and to fine-tune the timing between events.

Databases were updated by recalibrating data channels (generating slopes and offsets), entering values in the database, and manning the database generator.

Preston problems were encountered and resolved by cleaning and reseating the internal boards.

Data Analysis

Two hundred new headers were defined based on existing headers in the test article database.

Five features were added to the standard format file processing software to simplify and expand its use. The first feature created a new plotting option to output the data in Tecplot format, a second feature created an interface between the standard format file processing software and the Perch analysis program, and a third feature allowed a user creating profile plots to create an input file of header names versus individually entering the header names.

The fourth feature added two new plot types. The first plot type was for static data and allowed the user to draw lines between the points for the different reading number sets or ranges. The second plot type allowed the user to draw lines in-between the header pairs for each reading number in a profile plot.

The fifth feature allowed the user to type in a simple calculation involving two headers (instead of individual header values) and let the system plot the calculations.

Miscellaneous

Problems related to data being overwritten, the database generator not mapping to the appropriate database file structure, and the date changing when testing ran past midnight were resolved. Hardware problems related to the operation of Heise units and the Preston were also resolved.

Appendix N

Delivery Order No. 14

Data Acquisition and Analysis Enhancement

Data Acquisition and Analysis Enhancement

In support of the Compressor Research Facility computer upgrade, Battelle provided development, modification, and redesign efforts to maintain the readiness and enhance the capabilities of the embedded computer and instrumentation subsystems.

Under this Delivery Order, Battelle purchased the following items to continue the implementation of the computer replacement.

2 Removable Disk Systems

ZIP Backup Unit

4 mm DAT Unit

5 Xterminals

PCI SCSI Controller

3 Modems

Presys Power Supply

Cables and Connectors

Keyboard Protectors

Windows NT Advanced Server 3.5

WinDD Software Server

Miscellaneous Software Upgrades & Maintenance

These purchases and their installation continued the process of reallocating and merging the functions of several CRF computer systems into one system.

Appendix O

Delivery Order No. 15

Functional Area / System Manager

Functional Area / System Manager

General system and network management duties were performed for all Compressor Research Facility (CRF) computer systems. Many hours were spent maintaining, troubleshooting, upgrading, updating, and tuning the systems and network as well as educating users. Time was also spent devising system upgrades in preparation for upcoming tests.

Coordination was maintained with computer and network maintenance personnel to resolve problems, schedule preventative maintenance, and coordinate and communicate symptoms and solutions for various failures.

System Administration

System administration and troubleshooting duties were performed for all CRF computer systems, Xterminals, the CRF LAN, and the NES encryptors.

Disk systems were backed up, defragmented, and inspected. Several disks were swapped to reallocate larger capacities as required.

New forms and procedures were designed and installed to speed up and improve daily activities. Documentation of CRF systems continued with the creation, revision, and organization of multiple drawings, forms, and database formats.

Several VAX system hardware problems were resolved in-house. These included several independent tape drive failures and a power supply failure on the DVL disk chassis.

The VAX VMS operating system and most system support software packages were upgraded on VS4, VS1, PPX, and LAV. DEC VMS 6.2 was installed along with DecWindows/MOTIF 1.2-3, TCP/IP 3.3, FORTRAN 6.3, and C 5.0. Remote Device Facility (for remote disk and tape use) was upgraded to 4.0Q and the NCD Xterminal download software was upgraded to version 3.3-2 on all servers. Tecplot software and licensing was installed on VS4 and two Xterminals. System procedures were modified to work with or take advantage of new operating system software changes.

All software except the VMS operating system was upgraded on DVL. The VMS operating system will be upgraded when an engineering upgrade becomes available.

Intermittent network problems were encountered and ASD Computer Center personnel were contacted regarding problems and upgrades. Due to the nature of the network problem, it has not been completely resolved; however, it was reduced and will not seriously impact the CRF.

A PC Windows print driver was purchased and installed to support PC access to the large format, heavy duty, Printronix line printer.

A terminal was configured and connected to the CRF LAN to support diagnostics and tuning in the second floor Signal Conditioning Room (SCR).

Additional memory was installed in 22 Xterminals which were then reconfigured to use the increased resources.

CRF Network

The CRF network was modified to consolidate network support of the Turbomachinery facilities which consist of the Turbine Research Facility, Building 21, the Water Tower and the Building 20 High Bay area. The network was expanded to make it more efficient and conducive to the addition of more devices. Critical devices were minimized and redundant power supplies were installed.

To simplify and reduce the number of spares required to maintain the CRF/TRF network, the feasibility of using a network hub was explored. Various products were researched and a Cabletron network hub with management software was specified. This software enables the network to be easily modified and supplies basic information required to make accurate configuration and expansion decisions.

Upon arrival, the Cabletron network hub was assembled offline. The software was temporarily installed on a PC to allow the hub and software to be configured prior to installation on the CRF network.

The actual installation of the Cabletron hub was performed on a weekend to minimize CRF downtime. The entire core of the CRF network was dismantled and re-assembled using the new Cabletron hub; nearly all network segments were directly connected to the switching device in the hub.

Documentation for the network configuration was created and existing documentation was updated. In addition, the Cabletron UTP hub cabinet was reworked to organize the patch wiring.

In the TRF, a method was designed and constructed to isolate a LAN segment for classified processing. Network addressing was modified for systems on existing LANs which were absorbed by the network expansion.

A means to extend "secure" fiberoptic links between the Control Room and SCR is being researched to allow expansion of classified data transmission between the CRF secure areas. A preliminary design for extension of the CRF network into the Test Chamber was also developed.

Post-Processing VAX Upgrade Study

Cost-effective methods to upgrade the post-processing capabilities in the CRF were researched. After various options and available systems were considered, it was determined that the best approach would be to replace the VS4 and then use the VS4 as the post-processing VAX. This would provide the CRF with a powerful post-processing system as well as additional power for test functions.

Configurations were specified, quotes requested, and responses analyzed for the preferred configuration and alternatives. Due to funding constraints this project has been put on hold. Requests for best and final quotes will be solicited when funding becomes available.

Computational Fluid Dynamics 1 (CFD1)

A 4 mm DAT tape backup drive was configured and installed to provide backup capability. An external disk drive chassis and four removable disks were configured and installed to support proprietary data analysis. Pending generation and approval of security documentation, this system is ready to operate in classified mode.

A demo version of the World-Wide Web (WWW) browser Netscape was installed to support acquisition of system administration information from various WWW sites on the Internet. Information obtained from the WWW was used to configure the disk drives and 4 mm DAT tape backup unit.

LaTeX was installed to support equation-intensive papers written by CRF engineers. It will ease document transfer between the CRF and other scientific/engineering communities.

A new version of TCP-Wrappers security software was installed to allow the System Manager to deny network access to all network systems except those specified for communications with the local machine. The software was also configured to limit access from other machines to CFD1.

Electronic mail (e-mail) was set up to facilitate communications with users outside the CRF. In the future, all CRF e-mail will be routed through a Mail Host to provide centralized administration. The WPAFB Network Management and Control Center (NMCC) was contacted to set up the domain CRF.WPAFB.AF.MIL in the Domain Name Service (DNS). At the suggestion of the NMCC, the CRF will have a DNS which will be established when the hardware is received.

An updated version of Sendmail was installed to provide greater system security. Sendmail is the UNIX mail transport agent which uses the Simple Mail Transfer Protocol to deliver messages between hosts. The LOGIN banner was modified to include a warning to users concerning the misuse of government computers.

The Wright Laboratory standard for UNIX User and Group IDs was researched for use in the CRF. Discrepancies in IDs on various CRF UNIX systems were documented and will be resolved.

A Gnu C++ compiler was obtained to compile software available on the Internet. This compiler will also provide a faster means of installation for packages such as TCP-Wrappers and will provide a better executable as many of the codes are optimized for the Gnu C compiler.

ADA

The option of using the 8 mm Exabyte tape backup unit from the TRF to increase backup capacity and shorten backup time was researched; it was determined that this option is not cost-effective.

The software script, Operator Menu, and operator's notes were updated to enhance backup options. The backup script was installed on both the classified and unclassified systems.

PCs

Five PCs were upgraded (4 from 386/20s to 486/100s, and 1 from 486/25 to 486/100) as a cost-effective method to enable them to utilize application software which required greater system resources.

PC disks and memory were upgraded to provide additional data storage as well as support the migration to Microsoft Windows 95. Standard Ethernet cards were installed in multiple PCs to allow easier configuration and control. Windows 95 was installed on several PCs.

A VT-320 emulator was reconfigured on multiple PCs to correctly print to postscript printers thus allowing users to easily print their e-mail.

A great deal of effort was required to resolve problems accessing the FEDLOG supply program. The FEDLOG software is provided by another branch in Wright Laboratory and PCs must be reconfigured whenever the method used to provide the service is modified.

Access to the Logistics Material Control Activity (LMCA) supply system was provided to the technicians. The PC used in supply was modified to automatically backup the supply databases over the network. In the event of a catastrophic failure, the backups can be easily restored from the network.

Microsoft Access was upgraded to Version 2 and Pathworks software was upgraded on several

PCs to provide DECnet and TCP/IP connectivity. Harvard Graphics, WordPerfect for Windows, and FastTrack were removed from the network.

A PC was installed in the Technician's Breakroom to provide e-mail access.

A 100 Mb Zip Drive was purchased to help ensure that data from multiple vendors remains segregated. This external hard disk can be accessed through the parallel port of a PC.

An HP Color Scanner was installed and configured. Procedures for scanning black and white drawings, detailed color photographs, and text-only documents were written.

A TCP-IP stack was installed on the classified PC to support printing to the color plotter, and a new Ethernet card was installed to provide network access.

WinDD

Tektronix's WinDD (Windows Distributed Desktop) was evaluated to allow Xterminal users to access Microsoft products through the Windows NT Server. It was determined that a UNIX machine would be needed to act as an intermediary for the software. For evaluation purposes WinDD was loaded on an SGI machine and tested on an Xterminal.

NCD Ntrigue was researched as an alternative to WinDD. Although this software may be a significant improvement over WinDD, it is still being developed and is not commercially available.

The old TRF Sun Workstation 4/330 will be used as the WinDD intermediary, UNIX Mail Host, and Domain Name Service (DNS) server. Since this system does not have any internal disk bays, an external chassis, removable disk, and CD-ROM will be purchased to maintain compatibility between CRF systems.

NT Server

Coordination is being maintained with the Wright Laboratories (WL) Office Automation Standards Committee to determine the WL standards for NT servers and clients. These standards will provide common functionality and access to applications throughout the laboratories and when implemented will reduce the time required to install additional computers in the CRF.

An extensive amount of time was spent planning the CRF NT network. It was determined that the CRF would benefit by having its own NT server based on the considerations that WinDD is being used and the CRF is on a different physical network from the rest of PO which severely degrades network response time when data is transmitted over the network. The PO NT server will still be used to access PO drives and the e-mail server.

An NT Server is being established for the PC network. A Pentium-90 was selected as the hardware platform running Windows NT Advanced Server 3.5. QMS driver software was downloaded to support access to the Color Laser Printer, and Microsoft Word was installed.

All application software packages were copied to the NT server to speed up software installation. Software to perform license metering of applications from the server was researched and Express Meter 3.0 was selected. A demonstration copy has been obtained and will be evaluated.

Windows For Workgroups was installed on a PC for testing with the NT server and to determine the best configuration.

CRF Trouble Log, Tape, and Configuration Databases

The trouble log, tape tracking, and computer/network configuration databases were maintained and reports were generated as requested. Information continues to be gathered and loaded into the configuration database.

CRF Configuration Database

The CRF contains a vast number of systems, devices, etc. which requires the maintenance of manufacturer, model numbers, warranty, purchase date, power requirements, and tracking information. Without this data, repair, replacement, or relocation can be very time consuming. This data is in the process of being consolidated into a central, available, and easy-to-use database. While it is unreasonable to expect all details of existing equipment to be collected and added to the database, known sources of information and all new equipment is being incorporated. Microsoft ACCESS was used as the database engine since it is the Wright Laboratory standard. The design was based in part on feedback from known users and other interested parties. Standard reports have been incorporated into the database for often-requested information. Methods to search for, edit, and add data by "unprivileged" users has been incorporated into the design. Reports, forms, and other details are being revised and updated as required.

CRF Documentation Library

The CRF documentation library was maintained and updated. The Test Program section was reorganized by test, and a plan was devised to incorporate test article photos into the test section. Notebook spines were redesigned and implemented for all books in the library.

The Instrumentation section was updated to include laser system manuals as well as documentation on all newly purchased equipment. Manuals for equipment no longer in use were removed.

Functional documentation was reviewed and updated for Drive Lube Oil, the Discharge System, and Uninterruptible Power. Technical specifications, blueprints, and device and instrumentation lists were incorporated as appropriate. A review of PCAL and ZAD functional documentation is underway.

A *PC User's Guide* was developed to provide information about PC utilities available on the CRF PC network (such as Norton AntiVirus and Disk Doctor), network applications (including FAL and NFT), and the procedures required to transfer files between two systems.

A *Test Group Menu User's Guide* was developed to provide information about all options available on the Test Group Menu. These options include Test Article Graphics, Test Article Alphanumeric Displays, Test Article Directory, Standard Format Processing, Test Article Playback, Facility Graphics, Facility Plotting, Facility Playback, and Help.

Network configuration documentation was created and an updated overview of the CRF buildings was developed to document the route of the CRF network fiberoptic cable. All CRF / TRF floorplans and network diagrams as well as VS4 online Help screens were updated to reflect changes and enhancements.

Control Computer I/O Upgrade

Two DCT-1100 interfaces emulating DEC DRV-11s were installed on DVL. These interfaces were configured to communicate with each other to enable Control computer communications software to be developed and tested.

I/O communications problems were encountered with the firmware and the software driver. A new driver and firmware "patch" were obtained from the vendor and installed. One of the crates responded to input after initial problems were resolved, a second crate tested unsuccessfully, and the third crate tested successfully. Boards were installed in all 3 crates to fill the new database. Since controller problems still remain in crate 1 and the time code interface resides in this crate, the controller problems must be solved before time code is read from the interface board. Six termination panels (CAMAC) and additional boards and termination panels (Kinetic Systems) were also received.

<u>Filtering</u>

To better understand the filtering requirements for the new I/O system, facility plotting software was used to report on an insignificant AIS channel during the no-loads after the Core Drive Fan test. A filtered run monitoring a channel was made. An AIS card was then modified (filtering removed) for this channel and inserted into the AIS system. Channel calibration for the new card was performed and an unfiltered run was made. Plots were made from the two runs and compared.

The limit check database input file format was converted for use on the new Control computers.

Color Printer Study

An additional color printer to replace the Tektronix Color Phaser on the classified CRF network was researched. Tektronix was contacted; however, no data has been received. QMS was also contacted; quotes for the QMS Magicolor 28 MB printer were received from three sources.

Pressure Controller Replacement Study

A study was done on likely pressure controller replacements for the Heise pressure controller system. Requirements stipulated that the new system replace and surpass the present system by providing nine levels of control, having various on-board functions (leak-tests, etc.), and requiring less maintenance.

Specifications were drafted for the new controller system and vendors were researched through the *Thomas Register*, laboratories using or sourcing controllers, and contacts with pressure control companies. Although most companies were incapable of performing tasks required by the CRF, 14 vendors responded with information; 6 of these had viable products. After careful consideration the field of eligible vendors was narrowed to 3 and their pressure controllers were compared based on their impact on pressure ratio as a function of changing transducer technology. The Ruska pressure controller was selected based on the results of this comparison.

The concept of using a controller reference to replace the atmospheric reference in the pressure system was also introduced. This would greatly reduce the uncertainty in the measurement of the inlet pressures resulting in an improvement in overall pressure ratio. A new pressure system was designed that included a controlled reference. This analysis was documented and a presentation on this information has been scheduled.

ASME Paper

Title: *Measurement and Prediction of the Tip Flow Field in a Transonic Low Aspect Ratio Compressor*

This paper, written in conjunction with the US Air Force and NASA, details the tip flow field behavior in a low aspect ratio fan and uses data obtained during the ADLARF test. It was presented at the 40th ASME International Gas Turbine & Aeroengine Congress/Users Symposium and Exposition last June.

AIAA Paper

Title: *Influence of Inlet Distortion on Transonic Blade Loading*

This paper was written in conjunction with the US Air Force and the Swiss Federal Institute of Technology. It details the reduction and analysis of blade mounted static pressure transducer data obtained during the ADLARF test and was presented at the 31st AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit in San Diego in early July 1995.

Intercom System Replacement

As a result of a failed power supply on the existing Intercom system, potential replacement systems were investigated. The Eventide VR240 Digital audio logger was identified as a possible replacement for the intercom recorder. Specification sheets and quotes were obtained.

Facility Database Screens

A new Counts Display was created in Facility Playback to display the facility database (80 words at a time). Features were implemented to page forward or backward, go to a specified page, quit/restart the view, or print the current 80 hexadecimal values. Date, Time, and Page Number appear on the view. Limit-checked values appear in green if OK, white if off, yellow if in warning, and red if in alarm.

Laser Anemometer Distortion Data Reduction

ADLARF laser anemometer data was reduced and animation sequences were created to show flow field changes as a function of inlet distortion.

Computational Aeromechanics System

An Aeromechanics Data Acquisition and Analysis System is currently being implemented which will be known as the Computational Aeromechanics System. This system will include a finite element analysis and a computation fluid dynamics analysis for accurate predictive turboblading analysis, a Light Probe System for non-contacting blade vibration monitoring, the online Campbell Diagram System, the Strain Gage Monitoring System, an online stall prediction program, a casing-mounted pressure transducer system, and state-of-the-art digital data tape recording.

The new Strain Gage Monitoring system will monitor 108 channels at 60,000 samples a second or better. Upon acquisition of 1,024 samples from any one channel, a fast Fourier transform (FFT) will be performed on the data. The central CPU will gather FFT output for all 108 channels at 40 times a second, search for frequencies in a warning or alarm condition, signify the status of the channel, and generate graphical output including Waterfall and Campbell diagrams in near real time on Xterminals. The system will also be used to post-process strain gage data.

The new Kulite System will monitor 36 channels at a rate of at least 200,000 samples per second with a sample and hold capability. All output data must be saved for up to 6 seconds worth of data. The system should be reconfigurable so that a smaller number of channels can be monitored with a faster data conversion rate. Seventy-two pressure transducers (Kulites), an analog tape recorder switching network (to facilitate post-test aeromechanical data playback), a 64-channel VHS tape test data recording system, and an 8-channel thermal array recorder were ordered.

The new Light Probe System will monitor 12 light probes and the once-per-rev signal. The system must be accurate to within two nanoseconds. A source for high-resolution light probes was located and 12 were ordered.

Specifications for the workstation were defined. The hardware solution will consist of either VME or VXI I/O cards coupled with a host workstation. More than 30 vendors were contacted; however, only 3 VME vendors responded with viable solutions for the Strain Gage Monitoring and Kulite Systems. No vendor responded with an appropriate Light Probe System. The three VME proposals for the Strain Gage Monitoring and Kulite Systems were submitted for government purchase consideration. The search for a viable Light Probe System continues.

Computational Fluid Dynamics code was identified for forced response analysis using the Forced Response Prediction System (FREPS) from NASA. The software and documentation has been requested.

Uncertainty

The way in which uncertainty data is handled in the CRF was reviewed and documented. It was found that the software incorrectly handles the uncertainty calculations for statistical headers. A trouble log was generated to have the problem corrected.

Rotadata Tip Clearance System

As a result of the Air Force reduction in manpower, the option of remotely controlling the Rotadata Tip Clearance System was researched. Documentation was gathered and reviewed, a hardware interface was established, and software was developed to enable computer control. A terminal server was installed in the Signal Conditioning Room to support computer-to-Rotadata communications. Terminal server ports to each of the six Rotadata units were cabled and configured. Software was installed to create a logical link for each unit.

The implementation using computers to control the Rotadata Tip Clearance System was considered as it was being reviewed. Manuals were studied to obtain the correct communications protocols and the relevant functions. An interactive program was developed to allow the Rotadata units to be computer controlled and was designed to take advantage of the front panel controls. This program also displays clearance as well as the position of the touch probe.

Laser Anemometry System

Although the Laser Anemometer Data Acquisition software was streamlined and the documentation was enhanced for ease of maintenance, considerable documentation remains to be completed. The test preparation and data reduction software was relocated from LAV to DVL to decrease processing time by a factor of 10 or more. The traverse control software and hardware were upgraded and reconfigured for future tests.

Temperature And Pressure Systems Error Analysis Study

An error analysis of the CRF data acquisition system was begun. Uncertainty in gas turbine measurements was researched to obtain a better understanding of the steps required to perform an error analysis. Data acquisition system hardware and software was also researched. Due to the lack of documentation, the propagation of electrical signals had to be traced from the measurement point to the data reduction software. From this trace the model numbers of the relevant components were acquired to locate the appropriate device specification sheets. These specification sheets were then grouped into bias and precision errors.

The data acquisition software was extensively researched. This included the channel check, pressure calibration, pressure measurement, temperature measurement, and data reduction software. From this research, the underlying relationships in the ice point correction, cold junction compensation, and channel checks were obtained. This information plus the manufacturer's specifications provided a framework for an error analysis.

The concept of using spatial Fourier transforms in stall detection was studied. In order to understand the programs written to accomplish this task, selected LabVIEW manuals were studied. After an understanding for programming in LabVIEW was obtained, the programs for stall detection were reviewed.

The concept of using sound in stall detection is also being studied. The first step is digitizing the sound. The Mwave board (a sound board) is going to be used for this task. Some of the manuals for the Mwave board were reviewed to obtain a better understanding of its capabilities.

Channel Delete Software Enhancements

A new feature was added to the software to enable users to enter delete code reasons when deleting headers and store these reasons in individual historical data files as an aid for troubleshooting headers. Three new buttons were added to the database parameter display which can be used to assign a priority level (1, 2, or 3) to a channel that needs repair. A troubleshooting report is generated at the end of each test day and channels with the highest priority (Level 1) will be listed at the top of this report. Deleted headers are listed alphabetically below their associated channel. Channels not assigned any priority will be automatically listed on the bottom of the report.

Help screens were developed and all software changes were documented.

Temperature Measuring System

A new option was added to the Temperature Measuring System to enable the ice bath correction values to be used for an entire test instead of always being recalculated each time a data point is taken. A button was added to the Test Article Data Control screen to activate this option. Using the constant value option rather than the automatically recalculated values is desired whenever the ice bath fails in order to obtain more accurate data values.

Help screens were developed and all software changes were documented.

Appendix P

Delivery Order No. 16

GESFAR Test Support

GESFAR Test Support

GESFAR test support will continue to be provided under Delivery Order #20. The GESFAR test program is scheduled to continue until May 1.

Network

Worked with GE and WPAFB Network Management Center to establish network communications and accounts to support online test monitoring and data download during the GESFAR test.

Aeromechanics Station

Aerostation patching for the new test was performed and the patch panel was updated as necessary. Channels were set up to record 48-per-rev and acoustics data. Documentation was updated and distributed as appropriate.

Test Manning Support

Manning support was provided for the Software Engineer, Data Engineer, and Kulite Aeromechanics Engineer positions.

Software Engineer tasks included:

- Bringing the computers and links up
- Establishing the links between the various computers (VS4 and ADA)
- Activating the communication link with GE
- Entering the GE password and ensuring that data transferred correctly
- Starting the application software on VS4
- Troubleshooting computer, link, and device-related problems as they occurred
- Assisting users with problems, logging printouts, and running backup jobs at the end of the test
- Logging software changes
- Transmitting data to GE

- Shutting down the computer systems at the end of the test day

Data Engineer tasks included:

- Preparing the pressure and temperature systems for the test
- Changing pressure calibration and ZAD error tolerances
- Performing ZADs, channel checks, and pressure calibrations
- Troubleshooting out-of-tolerance and device-related problems as they occurred

Kulite Aeromechanics Engineer responsibilities included:

- Monitoring transducer signals to identify transients (e.g., stall)
- Supporting the Aeromechanics Engineer on data processing issues
- Monitoring recorded signals to verify data integrity
- Processing over-the-rotor Kulite data

Online Campbell Diagrams

An interface for the online Campbell diagramming system was built to allow the user to select up to 20 different parameters before acquiring data. These parameters include the analog-to-digital conversion rate, the channel list, the channel to plot online, the RPM range, and the frequency threshold. The new interface also allows the user to use a previously created setup file or save a setup file for future use. Several problems in the original code were resolved and the system was benchmarked.

The post-processing Campbell diagramming system software was modified so that the same namelist setup file created in the online system could be used. This allows the user to start the online Campbell software, save the namelist setup file before acquisition, and then use the same setup file for post-processing.

Operator notes were written for the Campbell diagramming software.

Laser Anemometry

Geometry and operating parameter files were prepared for the LAV system which will be used during laser testing later in the GESFAR program.

Transient Static Pressure Data Analysis

System requirements were identified for the Stall Precursor Detection System. Hardware and signal processing equipment was configured to test the PC-based software.

A new eight-channel digital signal recorder was installed and configured for real-time Kulite signal monitoring. Transient data for over-the-rotor (OTR) Kulite analysis, stall precursor analysis, and online stall monitoring stall characterization was acquired. Information such as the type of stall (rotating stall or surge), the stalling stage, and amplitude of the disturbance is being acquired.

The OTR transient static pressure data acquisition hardware and software were configured. The geometry and operating parameter files were prepared for the three rotor 1 blisks (GESFAR, FDA, GESRO) and rotor 2. Data is being acquired online and processed during or shortly after each test period. To date 275 data points have been recorded and 6 have been reduced.

Trouble Logs

Various Facility Graphics screens were modified.

- SV/SB Control (Screen 13) was updated with the new SV/SB schedule, and stator 2 information was removed.
- Stator 2 information was removed from SV/SB Channel 1 (Screen 40).
- Stator 2 and bypass discharge valve information was removed from Variable Geometric Device (Screen 44).
- The Critical Channels (Screen 50) and CC Level Test (Screen 53) were modified for the new critical channels.
- The DPL-10 header on Facility Graphics Drive Lube Oil - 3 (Screen 16) was changed to VPC-05 to match the system functional documentation.

All modified software was documented, tested, and promoted.

The level box for the test article lube oil reservoir tank was modified to check the indicated bits to display High Warning, High Alarm, Low Warning, and Low Alarm faults.

For the vacuum system, two low fault conditions were combined with two new high fault conditions. The level box will now check the indicated bits to display High Warning, High Alarm, Low Warning, and Low Alarm faults.

The facility database file structure latch bits were modified and level faults were added. Objects for Test Article Lube Oil chip detectors and delta-P sensors 3 and 4 were commented out of the software and hidden on the Facility Graphics screens. New data types were added.

The Test Article Data Control and Print Static software was updated to allow modified ZAD values and thresholds. All software changes were documented.

The engineering units software was modified and two new routines were added to the reduction software to enable area averaging and mass averaging to be performed. Additions were made to the Test Article Data Input database for the new flow calculations to allow for the requested plots. Documentation was added to the *Database User's Guide* on the use of these two new routines.

The statistical routine which calculates enthalpy also calculates the ratio of specific heats (gamma) for a given total temperature and specific humidity; the software was modified to use the gamma capability. Software changes included:

- Modifying the test article database generator to allow type 20027 statistical headers to have 3 headers in its header names array: the total temperature, specific humidity, and calculated value of gamma.
- Modifying the Engineering Units Conversion software to check the number of statistical headers associated with a type 20027 header. If there are 3 headers, the call to the statistical routine is revised so that the third header can be modified. The routine will then calculate gamma and place the value in the engineering units and corrected engineering units database file structures.

- Adding 4 headers to the test article database input file for gamma at 4 locations (inlet, stage 1, stage 2, and 2.3).

In addition, three new headers were added to calculate enthalpy at stages 1, 2, and 2.3, and the proper gamma header names were inserted in the names array.

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The reading for the Exciter 3 voltage (E3-V8) was not displaying correctly on the black & white and color displays. A logic error was discovered when the F2DATI software (which reads the raw FCC2 wide-range signals and loads them in the database) was checked to determine the cause of the erroneous E3-V8 reading. This error caused the E3-V8 reading to be mixed with 3 other inputs. The software was modified to correct this problem.

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The Test Article Lube Oil tank level and vacuum pump indicated a low warning condition during a run. The logic for the low warning condition for both of these headers was incorrect. The software was corrected and then tested in Facility Playback.

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The limit-check database was modified to turn sensors on or off based on the different gear ratios. Facility Graphics High Speed Gearbox - Temp (Screen 34) was modified to display the sensor values. The information window was modified to allow the limit-check database modifications to be viewed by the user. A copy of the updated limit-check database was placed at the Facility Engineer's Station.

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Software changes were made to the Database Links, Engineering Units Conversion routines, and to the Test Article Database Input and Facility Database Input files to enable the critical channels to download correctly. An algorithm in the Database Links software was replaced with a routine that converges faster and travels the full range of counts. An indexing variable was added to the Engineering Units Conversion routines to enable the reference header to be read and indexed thus correcting the reference header pointer problem. Changes involving gains and tolerances were made to the Test Article Database Input files, and changes involving the facility database index for several headers which had changed signal conditioners were made to the Facility Database Input files. Hardware changes included changing gains and divider cards as well as recalibrating a flow. Changing the gain settings for several of the channels allowed the signal to reach its full span and allow the fault limits to be reached.

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The range for the stator vane speed on Facility Graphics SV/SB Control (Screen 13) was modified to accurately reflect the stator vane speed. The range had been displaying at a value which was 5% higher than the actual speed.

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The Clearance System software was modified to check the function of the Rotadata clearance microunits. Since the probes must be parked prior to rotation, the software checks the status of the probes. If the microunits have been turned off, an error message displays on XT05. If the microunits are on but the probes have not been parked, the software will park them. Manually toggling the rotary dial on the microunit between the Park and Datum positions will also park the probes.

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The Facility Reduction software was modified to reflect a non-terminating alarm for the PDSH110 (differential pressure) header and the latch bit was removed from the Facility Graphics TALO Supply (Screen 17) and facility database. This modification resulted from a change in PLC logic.

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The Test Article Database Generator software was modified so that an error message will be written when a critical channel falls outside the allowable range. The operator can still use the database when it is in this condition.

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The Test Article Database Generator software was modified so that the initial default values and the default values in the body of the code for the low and high alarm action codes are both set to zero to indicate no action.

The Channel Check software was researched and documented. Various improvements were made:

- All channels more than 50 counts from full scale on the level 2 static data point are now flagged as bad.
- The averaged low counts comparison with 0 was changed from 200 to 25. All channels more than 25 counts from 0 on the level 1 static data point are now flagged as bad.
- The software was modified to compare new high counts minus new low counts with old high counts minus old low counts not greater than 10. The software had been using a slope deviation greater than .5.
- The software was modified to compare new low counts with old low counts not greater than 10 rather than use an offset deviation greater than .05.
- Percent change calculations were never used. This software was removed.
- The channel check printout was modified to include delete code reasons.

Facility Playback was used to research how data was displayed on Facility Graphics Drive Lube Oil-3 (Screen 16); it was reported that no data displayed when the bypass was on but did display when oil was sent to the test article. It was determined that Facility Graphics Drive Lube Oil-3 is responding correctly as requested in a previous trouble log. Pressing the Fault Reset button will also clear a sequence fault and allow the data to display.

A Dry Well Calibrator with intelligent RTD probe was borrowed from Kaye Instruments and successfully used in conjunction with a voltmeter and the ice bath to calibrate arc rake, inlet, and ice bath thermocouples. The data was tabulated but the decision to enter this information into the database as a correction curve has not been made. Research on the Dry Well Calibrator will continue.

The Test Article Data Control software was modified to provide the capability to send Channel Check Reports to the laser printer in the Control Room, to the line printer, or to the LN03 printer in the Triangle Room.

The Print Static software was modified to retrieve the five ZOC box temperatures, convert them to degrees Fahrenheit, and then place the values on the ZAD printout beside their respective controllers so that the ZOC box temperatures are now known when a ZAD is reviewed.

The Test Article Data Report software was modified to generate a new Troubleshooting Report which sorts channels into pressure, temperature, and miscellaneous categories. Each channel type begins on a new page and is further sorted according to priority. Using separate pages for each channel type enables the report to be easily separated so that more than one person can investigate channel problems simultaneously.

The Calibrate and Print PCAL Channel software was modified and a new routine (Sort By Scani) was created to enable the PCAL Bad Channel Report to print a list sorted by pneumatic connector. An error in accessing the storage of PCAL slopes and offsets was discovered while working on this trouble log; they were offset by one index position which caused many slopes in the printout to have a zero value. This error has also been corrected.

The Test Article Data Control software was rewritten to reorganize the code, streamline the main routine, and add functionality. Software code used to calculate the curve values for pressure calibrations was moved to the new routine Get PCAL Curve Data. All pressure controller communication and button sets/resets affecting ZADs and Kulite scans were moved to the Perform ZAD routine. These changes will allow Monitor data to be taken while the ZAD is executing; error messages will be written if problems occur.

Heise calibration was researched. The last six calibration certificates were obtained and plotted to determine any significant deviations. It was discovered that Heise #1 had a significant deviation but the others closely matched the original calibrations.

It was determined that the PCAL and ZAD tolerances were not acceptable for the PCAL software. Software modifications were made so that new tolerances were calculated based on the precision accuracies of the calibration system and the ZAD tolerances were changed to match those values.

Troubleshooting was provided as necessary to resolve numerous problems with the pressure system. These problems included a PCAL channel failure in ZOC box 3, leaking ZOCs, uncapped pressure tubes located above the strain gages, and ZAD channel failures in ZOC box 1. All problems were resolved.

Procedures were written for changing the ZAD setpoints and tolerances as PCAL setpoint and PCAL stability wait time.

The problem of controller #2 indicating an offline status but the ZAD still being successful was researched. It was determined that although the controller was in control mode at the proper setpoint, the unit was considered offline because it did not respond to the software. Since the controller was still controlling, the ZAD was successful. Procedures were written and incorporated into the troubleshooting section of the Operator's Notes which will help correct similar problems that may occur in the future.

The Presys power supply and fiber optic modems were replaced to resolve intermittent Presys problems.

When it was discovered that ZOC 2-7 was failing the ZAD possibly due to leaks within the ZOC, three ZADs were performed to ensure the ZOC was actually bad. ZOC 2-7 failed every ZAD and a job task was written to replace the ZOC. After the new ZOC was installed, three more ZADs were performed to ensure it was working properly.

A new pressure system (DSA-3000) is being evaluated for the CRF. It was determined that this evaluation unit could not be integrated into the VS4 because the unit did not have a TCP/IP interface. TCP/IP is available on production models. Additional system requirements were also determined. An Ethernet card was installed in a PC and communications with the DSA-3000 were established.

The process of integrating the control of the Rotadata Tip Clearance units through the static data point button was begun. The Volt Clear software was modified to check for errors in the units as well as valid characters returned by the units. In an attempt to solve intermittent software problems which caused the software to abort, a new routine (Reallocates) was added. When the software aborts, this routine de-assigns and de-allocates the units and then re-allocates the units so that the software doesn't have to be rebooted and testing is not interrupted. The problem was finally solved when an un-initialized variable in the code was found and initialized.

Appendix Q

Delivery Order No. 17

Advanced Concepts Fan (ACF) Analysis

ACF Data Analysis

VS4 Software Modifications

VS4 software modifications were made to support analysis of the ACF data. Channel Delete software was modified to create a data file for each header to record its delete/repair history, add a new button for channel priority repair, automatically write the date to the file and delete code screen, provide adequate space to type in a reason for a channel delete, modify the troubleshooting report to prioritize the channel to be repaired, and add a column on the troubleshooting report for documenting repair reasons.

A directory was established for the new data files. One file will be generated for each header when the user enters a delete code reason on the Database Parameter Display. Once the file is created, every new delete code reason will be appended to the file. Delete code resolutions may also be entered through the Database Parameter Display and appended to the information files. These files can be used to study the history of any header that has encountered problems.

Three new buttons were added to the Database Parameter Display, each with an Urgency Repair label. Deleted headers are sorted alphabetically in descending order of importance. Any deleted headers which have not been assigned a priority are automatically given the lowest priority. When the troubleshooting report is printed, the most critical channels will appear at the top and the least critical on the bottom. The last date on which the header was deleted also appears on the report.

Playback software was modified to allow users to create new headers on a standard format tape. A user-definable namelist input was devised to specify the new header names and how they are to be calculated.

Help screens were added to explain the new features and all modified software was documented.

Tape Review

A review was made with P&W of all analog tapes used during the ACF test. It was determined that analog tapes from Stator 1, Stator 2, and miscellaneous instrumentation could be degaussed. A trouble log was generated and degaussing was performed.

Strain Gage Data Reduction And Analysis

To support generation of the ACF Aeromechanics Test Report (see WL-TR-2028), Campbell diagramming software was reconfigured to produce the diagrams in a post-test mode.

High-Frequency Response Pressure Data Reduction

Static pressure measurements from the tip region of the ACF fan were obtained at twelve different operating points during the test. Eleven low-frequency and eleven high-frequency response pressure transducers were used to acquire these measurements. This data was then reduced on the CRF Analog Data Analysis computer. Online calibration procedures were used to estimate the calibration coefficients to convert the high-response transducer signals to engineering units. The resulting measurements were used to produce contour plots that resolve intra-blade flow structures at the fan blade tip. Important flow phenomena were identified and discussed in detail in an analysis that was included in the ACF Test Report (see Section 5.3.6 of WL-TR-95-2137).

Transient Static Pressure Data Analysis - Stall Analysis

Transient pressure data was reduced and analyzed to determine the basic character of the documented stall events that occurred during the ACF test program. This data was acquired using four sets of eight high-response pressure transducers positioned at four different axial locations in the test article. The transducers measured pressure fluctuations that resulted from compressor stall. They also measured pressure disturbances called "stall precursor waves" which occur just before the onset of stall.

Data from five stall events was studied in detail. Stall characteristics such as stall frequency, the stalling blade row, and the general severity of the stall event were identified and discussed in an analysis included in the ACF Test Report (see Section 5.3.6 of WL-TR-95-2137). Additional stall data was made available to test a stall detection and avoidance system that is under development for CRF test purposes.

Laser Data Reduction

Reduction and analysis of laser data from the ACF test was attempted. This task was only moderately successful due to a number of problems that occurred before, during, and after testing. Some of the data seems to be recoverable, but problems with the data reduction software prevented quick data reduction. Unfortunately, much of the software that drives the acquisition and reduction of laser data was written specifically for a previous test program. Problems were further complicated by the current laser software manager's unfamiliarity with the algorithms used in the software. Most of the problems associated with the data reduction have still not been identified. No official documentation of the data analysis has been completed at this time due to the lack of reduced data to document. Laser data reduction will continue.

Appendix R

Delivery Order No. 18

Functional Area / System Manager

Functional Area / System Manager

The CRF library as well as PC, trouble log, manuals, designation, and tape databases were maintained and reports were generated. Daily, weekly, and monthly full backups were performed on all TRC computer systems.

System administration and problem troubleshooting was performed for all CRF systems and peripherals. System procedures were updated, and system logicals and identifiers were added or modified to meet the changing needs of the CRF. Tape drive problems were resolved and the ScriptServer print software was upgraded.

Modifications were made to the VMS development computer to facilitate faster execution of Computational Fluid Dynamics programs. Memory was increased and a new account type was established to support offsite processing. The new account required additional system and account tuning and may require further system modifications to maintain CRF security.

A print queue was established for the Printronix line printer to allow designated printouts to be generated at a specified time. This will facilitate printing of large files such as the supply database.

To maintain controlled file transfer of system/network management files, an anonymous FTP account was established on the CRF VMS systems. This will allow a network bootup security check by the UNIX systems as well as eliminate the need to create accounts for vendor personnel.

VS4 experienced an intermittent problem which caused disk errors and resulted in bad files. The problem was researched; a firmware upgrade for the system was obtained and installed which solved much of the problem. System level tuning of several parameters, and disk swapping and reformatting resolved even more of the problem.

An electrical storm accelerated VS4 SCSI problems. Diagnostics revealed the problems were caused by the SCSI controller on the system motherboard and were resolved when DEC replaced the board.

DVL also experienced problems with tape access and corrupted system disk files as a result of the electrical storm. The tape access problems resulted in the current system backup being unusable. The tape access problems were resolved, the system was rebuilt from an older backup, and then the system was reinstated to the current configurations.

Backup problems encountered on ADA were traced to the SCSI controller. The problem was resolved by re-seating the SCSI controller.

Modcomps

Disks crashed on two Modcomp systems. Since the estimated repair cost exceeded the cost of new disk drives, new disk drives were purchased for all Modcomp systems.

The 4 mm SCSI tape drives on the Monitor, FCC1/TAC1, and FCC2/TAC2 were configured and tested. These tape drives will simplify file transfers between the Modcomps and VMS systems as well as make tape backups and archives easier to store.

Computational Fluid Dynamics 1 (CFD1)

A security review of CFD1 was performed, files and accounts were cleaned up, and a hardware memory upgrade was researched.

The method of data storage on CFD1 was modified in preparation for upcoming tests.

The new version of Pressure Sensitive Paint software was installed.

CFD1 memory was upgraded from 64 Mb to 192 Mb to enable the system to work with large data sets for CFD solutions. This memory will also be used to handle future memory-intensive aeromechanics tasks.

PCs

Two dual-CPU 133 MHz Pentium PCs were purchased to replace the 90 MHz Pentium PC and 486 PC which currently provide Xterminal access to PC applications as well as file and print sharing, web service, domain name service, and other services to most of the CRF and TRF PCs. One of the new PCs will run the WinDD operating system and will only be used for Xterminal access. The second PC will run Microsoft Windows NT and provide all other services including new features such as license usage monitoring, redundant hard disks, and direct access for Xterminals to the WinDD server.

When the POMIS application PerformPro became unavailable without warning to CRF users, the problem was researched and it was discovered that the application had been reconfigured to allow only three concurrent users. Invariably the software was in use whenever CRF users attempted to access it. Replacement software for CRF users was ordered.

Logon scripts were created for all PC users on the NT server to automatically connect the network drives to Wright Laboratory standard drive letters. The new logon script also requests the POMIS account and password so that it is not necessary to store this information in an unsecured location on the PC.

To support the transition of PC Windows users to Windows for Workgroups and Windows 95, the TCP/IP network protocol software was installed on the Pathworks PC server and the server software was configured for use.

Windows NT system administration training was attended which included topics such as connectivity between the NT server and clients used at the CRF (Windows for Workgroups and Windows 95) as well as fault tolerance of the server, directory structures, security issues, and RAID support.

Windows for Workgroups was installed on seven PCs to enable users to connect to the NT server to access file, print, and application services. Multiple PCs were upgraded with the new version of CRF PC Client Configuration to migrate the users from the DEC Pathworks server to the new NT server. NT server users will be able to access files on the Pathworks server until all users have been migrated to the new server.

A baseline PC configuration was developed for CRF client PCs which will decrease the time required for PC software installation as well as provide standardized support for all PC applications in the CRF.

The CRF classified PC configuration was reviewed to meet anticipated future requirements. Additional disk drives and chassis were proposed and are being purchased. Security documentation was written to support this PC.

Miscellaneous BIOS configuration, e-mail, and printing problems were resolved.

PowerVT was installed on multiple PCs to enable e-mail to be printed from local PCs.

PC modems were researched and ordered to provide the capability to download various drivers and software updates which are only available on corporate bulletin boards.

Micrografx Designer training was provided for government and contractor personnel to teach PC graphics procedures. Illustrated graphics techniques included object layering and grouping, option capabilities, drawing shortcuts, and building a library of often-used objects.

Purchases included cables, SIMM modules, PC software, ZIP disks, network taps, and cleaning pad kits.

The Paradox database software was researched as a possible replacement for Access.

E-Mail

A study was performed to review alternative, user-friendly e-mail systems which could replace All-In-One on POMIS. The decision was made to use Netscape Navigator as the Web browser for the CRF to access the Wright-Patterson Bulletin Board. Licenses were purchased and software was installed.

Wright Laboratories selected TeamLinks for the e-mail system; it will be installed when the software and licenses have been acquired. Netscape will be used temporarily for email services.

Netscape 1.0 was upgraded to version 2.0 and then configured to work with WinDD to provide e-mail capability to Xterminal users without desktop PCs. Problems encountered while storing customizing options for each individual user were resolved by using the registry editor. This solution was obtained through the WinDD users mailing list.

NT Server

New accounts were established on the NT server for Windows 95 and Windows for Workgroups users. The server was backed up as necessary to protect the data.

A Backup Domain Controller was set up to protect the User Accounts Database in the event of a system failure. The power supply for the NT server was switched to the UPS system to protect hardware and data in the event of a power outage.

An NT Trust relationship was established with the WL NT domain to allow CRF PC users to access applications provided by Wright Laboratory.

A Domain Name Service (DNS) was implemented on the CRF NT server to provide the capability to use e-mail to transfer technical files. The Computer Center was consulted regarding the installation.

License monitoring software was evaluated, purchased, and installed to track and limit application access.

The 4 MM Digital Audio Tape unit used to backup the NT server failed and was replaced.

Microsoft Office Suite 95 was installed on the server for Xterminal users.

Networks

<u>Protected Data Systems (PDS)</u>

A study was performed to determine methods to permit various modes of classified data transmission between CRF secure areas. Information on PDS requirements was obtained from base security personnel and an existing PDS was located.

Security approved a preliminary PDS design which permits various modes of classified data transmission between TRC secure areas. This design uses an alarmed pressurized PVC pipe to secure the data transmission. Engineering concepts such as inserting the fiber into this pipe are being further researched.

The CRF is continually adding communications requirements between the display/analysis systems in the Control Room of Building 71B and the signal origins in Building 20A. The signals vary in format and includes DI/DO, RS-232 serial, IEEE 802 Ethernet, and a number of proprietary protocols. Future additions are expected to add some form of video protocol, etc.

A secure 48-connector fiber optic cable installation between these areas is estimated to allow sufficient bandwidth and separation of signal pairs to allow any foreseen data mix to pass without the concern of under-protected data. The use of fiber optics provides maximum bandwidth on individual conductors, eliminates radio frequency (RF) emanations and cross-talk, and is predominate enough in the marketplace to provide flexible solutions for nearly all protocols.

The secure pathway would follow the cable tray from the Building 71B, Room 240 communications closet, up the "Tower," and across the catwalk to the Building 20A, Room 213 communications closet. Both of these communications closets are located in secure areas. Final design considerations may extend this path into adjoining rooms within the secure area in Building 20A.

The proposed PDS would be constructed of 4-inch Schedule 80 PVC pipe with its sections welded together with PVC couplers and PVC cement. It would follow the path of an existing cable tray and probably hang above the tray itself for most of its distance. This would make the PDS reasonably easy to visually inspect.

The pipe would then be pressurized above 1 atmosphere to the extent that any pressure loss could be detected by a set of redundant transducers. These transducers would only need to trigger a local alarm since the CRF does not allow unmanned classified processing. A pressure gauge would be installed where it could be visually checked prior to classified operations.

Since the PDS would be exposed to outside temperatures, the transducers would have to allow temperature-induced pressure variations without alarming. Design details of the local alarm are currently being researched.

One or more fiber optic cables would extend through the sealed PDS for a total of 72 conductors. These conductors would be standard 62.5/125 micron-graded index multimode fibers. Both ends of the cables would be terminated in fiber optic distribution cabinets in a similar manner to the current unclassified fiber optics.

CRF Network Extensions

A design for the extension of the CRF network to the Water Tower and into the Test Chamber was developed. An FMR was written, hardware purchases were defined, and security issues were addressed. A temporary network connection was installed to allow the use of an Xterminal in the Test Chamber to meet immediate needs.

Battelle installed a modular multiport repeater with an uninterruptible power source in the Water Tower and connected the fiber optic links to the central TRC network hub; this area is now part of the TRC network.

Other Network Upgrades

A fiber optic cable was laid to the unshielded twisted pair (UTP) concentrator (Cabletron Stackable Ethernet Hub Intelligent (SEHI)) to improve reliability and performance. This SEHI encountered problems that prevented access to management and statistical functions; these were resolved with assistance from Cabletron.

System And Network Security

Automated procedures were set up to run daily security checks on each VMS system, combine the results, and mail the results to the Computer Security Officer. This process ensures the Computer Security Officer has the security information he requires without the need for specialized TRC knowledge or special system privileges.

A set of TRC network and computer security documentation was submitted for approval; changes were incorporated as required. Several facility tours were conducted for security personnel.

WinDD

The WinDD server and client were upgraded to version 2.0 after extensive work with the vendor to obtain the correct versions for both the server and the client. Multiple problems with the upgrade were encountered and solved. The WinDD 2.0 Service Pack was also obtained and will be installed after it is fully tested.

A performance analysis of two WinDD competitors showed that although these products were as fast or faster than WinDD, the improvement did not justify the product cost. The possibility of using NTrigue rather than WinDD was investigated because NTrigue directly supports the X protocol and works directly with the CRF's NCD Xterminals; WinDD uses another host as a mediator.

The operating system patch WinDD 2.0 Service Pack 3 was obtained and installed to fix known system bugs as well as prevent future problems.

Control Computer Upgrade

Several meetings were held concerning the Control computer upgrade. Twenty-two different tasks were identified which must be completed before the facility and test article can be controlled by the new computer systems. Estimates were made on the length of each task and a PERT chart designed.

Specific areas addressed in these meetings included:

- The overall design of the software
- How the software on VS4 will communicate with the new Control computers.
- How the Control computers will communicate with each other to share data as well as how memory on both computers will be kept up to date.
- Event log communications between the new Control computers and VS4.
- What the new trim panel (panel 3) will look like, how it will present an interface to the user, and which computer system it will run on.
- Which computer system will handle the old panel 2 interface, and what the new interface will look like.
- What the executable images will be on each of the new Control computers.

It was decided that the new trim panel would be a DataViews interface running on Control Computer 1. A new trim panel screen and associated software were created to replace Panel 3 in the Control Room. The interface was designed with the graphical editor, and software was written to control the interface. A link program was written to allow communications between VS4 and the development VMS (DVL) using the DCT interfaces that will be used on the Control computers. The DCT link program will be used to keep the shared memory of the new Control computers up to date; benchmarks were run to test the speed of these links.

Different types of socket programs were discussed as possible options for communications between VS4 and the Control computers. A pair of socket programs were developed to send data between VS4 and DVL. These programs will be used to explore various methods of communications. Socket programs will be used to send test article peculiar and critical channel data from VS4 to the Control computers, and to send facility and digital data from the Control computers back to VS4.

The repaired crate controller for the CAMAC I/O system was received, installed and tested successfully.

Meetings were held with Modcomp to discuss alternate solutions for the Control computer upgrade.

Several Xwindow utilities were converted from the VAX VMS to Alpha VMS as part of the computer upgrade plan to replace VS4 with an Alpha CPU.

Power Monitoring

The Power Monitoring software was migrated to VS4. Software and graphics were modified as appropriate. All software changes were documented.

Laser Anemometry System

Documentation of the Laser Anemometer Data Acquisition software continued as time permitted.

Rotadata Tip Clearance System

A meeting was held with Rotadata to discuss the accuracy of the touch probe and methods which could be used to verify whether the probe was providing a true value of clearance. Backstop was discussed as a possibility for verifying whether the case or the blade is expanding.

The rotadata tip clearance software was modified to indicate its current function. Software was modified to obtain a clearance value, to obtain backstop measurements, and to average clearance values.

Tip Clearance Measurement System

Design of a new clearance system was initiated in the mid-1980s by a small business called Vatell (now called Microcraft). This project culminated in an instrument that could take clearance data which would be compatible with the current rack-mounted Rotadata system. Two units were purchased by the Air Force in the early 1990s.

A trip was made to Vatell to acceptance test the new tip clearance measurement system as well as obtain an understanding of system operation. The code used to obtain clearance values was examined, the method used to calibrate the clearance probe was learned, and demonstration runs on the test rig at Vatell were observed. During the demonstration runs, the probe was mounted on a micrometer and moved to different lengths; the instrument exhibited great repeatability in determining clearances. It was also discovered that a constant in the software may have to be changed when the instrument arrives at the CRF.

The units arrived in November of 1995 with a number of unresolved problems: the probes were the wrong size, there were no cables with the instrument, the control units had a noise problem that caused the units to reboot randomly, and there was no software with the units.

We continued to work with Microcraft to assure all problems were resolved appropriately. It was decided not to re-size the probes, but to make a "Kulite block" for them. Cables were ordered and the control units were returned to the manufacturer to have capacitors soldered onto the power source to eliminate noise. Plans were made with Microcraft to borrow their test rig.

A design for control and data analysis software to be used with the system was initiated. The units were mounted in the existing Rotadata rack and connected to VS4 via the network. A sketch of the calibration procedure for the new units was created.

The loaner test rig was delivered to the CRF and placed in the First Floor Signal Conditioning Room. Probes, connectors, and cables for the new Vatell system, which arrived late last year, were sent to Microcraft for assembly.

Enhancements were made to the digital data system report.

Pressure Upgrade

A presentation was given to discuss the results of the pressure controller uncertainty analysis which was performed. Three Ruska pressure controllers and one vacuum pump were purchased for the pressure system upgrade, and methods to implement a pressure confidence system were considered to ensure accurate test article pressure measurement. Four drawings illustrating the current system, interim system, final system without confidence, and final system with confidence were made. These drawings will be included in the facility modification request (FMR) that is being written to integrate the Ruska pressure controllers into the pressure system. The upgrade will be performed in stages since the pressure lines cannot be replumbed during testing. Ruska pressure controller plumbing, electrical, and software information was obtained and documented.

Meetings were held with CRF technicians regarding the location of the pressure system; various technical details were also discussed and resolved. Presentations were given to government personnel.

A job task was submitted for drafting support for this effort.

A pressure scanner on loan from PSI was obtained for testing as a possible replacement for the Presys pressure system. This scanner was returned after it was tested for system compatibility and functionality.

Channel Check System

The channel check software was researched and documentation was written to help users obtain a better understanding of the software. This information was presented at a meeting discussing the channel check system.

Channel check software and hardware were evaluated for accuracy within CRF constraints. An uncertainty analysis based on information obtained during the last year was performed on the channel check system. Existing methodology and error analysis examples were reviewed to determine a viable method to perform an error analysis. It was concluded that no developed method existed which exactly reflected the CRF data system.

A procedure for an effective error analysis of the CRF measurement system was developed and various elemental errors associated with equipment in the measurement system were re-evaluated. These errors were entered into a spreadsheet to enable variables and data presentation to be changed easily. Software code involved in the calculation of a measured pressure was also reviewed and the equations used to calculate pressure were obtained. Elemental errors derived from the analysis of the measurement system were used in these equations to obtain an uncertainty value for a measured pressure. Then, the spreadsheets used to calculate elemental errors were merged with the spreadsheets using the propagation of errors formula to calculate the uncertainty in the channel check system as well as the pressure measurement system. This combined spreadsheet was designed so that the sensitivity of the CRF measurement system to various changes in that system can be determined. The theory of the uncertainly analysis as well as the analysis of the channel check system was documented.

The decision was made to revamp the uncertainty analysis software on VS4 when it was discovered the method for calculating uncertainty in the statistical software was incorrect. The software had been using a single equation algorithm to handle every condition for all the statistical routines which resulted in incorrect answers. Software development was begun to implement individualized equation algorithms for each statistical routine. New uncertainty software has been completed for the measured pressure channels. The software design to send bias errors, precision errors, and degrees of freedom from the data acquisition software to the statistical calculation software has also been completed.

The application software was modified to accommodate the new C compiler on DVL.

Electronic Noise On The Pressure And Temperature System

During the plotting of the ice correction and universal temperature reference temperature A headers as a function of time, it was discovered that temperatures between scans fluctuated by as much as 0.6° F due to electronic noise. Due to time constraints, it was decided to lessen system sensitivity to the fluctuations. The gain of the measurement headers was set at values which were too high thus giving less resolution so one count would be equivalent to a greater number of degrees. It was also discovered when more temperature headers were examined that the universal temperature device (UTR) headers were jumping as much as 0.4° F. Since these headers were already amplified to their full-scale value and every measurement header depended upon these temperatures, it was decided to implement a moving average filter on these headers. This decreased the sensitivity of the temperature measurement headers to noise and provided a temporary solution to the problem.

A permanent solution involves replacing the inaccurate power source for the resistance temperature device (RTD) which is used in the measurement of the UTR block temperatures. The vendor was contacted about the problem, a precision thermometer was obtained, and the problem was resolved. No decision has been made to purchase the unit due to cost and the possibility that the system will be replaced in the near future.

New Temperature System

The TruTemp System by Kaye Instruments was researched as a possibility for the new temperature system. Kaye Instruments was contacted and a presentation was attended. At this presentation, the Dry Well Calibrator with intelligent RTD probe was also demonstrated. The calibrator was obtained for evaluation purposes and successfully used to calibrate arc rake thermocouples. Research on the Dry Well Calibrator will continue. The TruTemp System will also be obtained for evaluation in the CRF. This system will replace the UTR boxes, Preston amplifier, signal conditioner, multiplexors, and Presys as well as provide a permanent solution to the electronics noise problem on the pressure and temperature system.

Blade Vibrations Seminar

A Blade Vibration Seminar sponsored by the Air Force was attended to enhance support capabilities for the Aeromechanics Station.

Computational Aeromechanics And Data Acquisition System (CASDAS)

Five proposals for the new CASDAS were evaluated. Two of these were incomplete and were disqualified; the remaining three proposals met all the specifications but they exceeded the cost requirements. As a result, the required system capabilities were re-evaluated and reduced and then the new system specification was sent to the vendors for re-bids.

Vendor questions concerning the new CASDAS were answered and the system's salient characteristics were updated.

Proposals were received and evaluated. Three proposals are still under consideration.

Documentation

A trip was made to the Society for Technical Communications conference to obtain information on online documentation as well as improve skills in documentation management. Work continued on the file conversion of the original CRF documentation from Enable to MS Word so that it can be reviewed and brought up to date.

CRF operator notes were created or updated to reflect hardware and software modifications. A procedure was written to enable offsite customers to view Compressor Data Alphanumeric Displays and to obtain static data points.

The CRF and TRF floor plans were updated to reflect network and hardware changes.

A channel check flow diagram was designed to enable users to better understand the flow of the software. This diagram will also be useful for resolving channel check trouble logs.

A Network Profile document was developed to provide an overall description of the CRF Local Area Network. This document includes information about network construction and modifications as well as expansion capabilities.

Documentation was written for the use of the new Modcomp disk systems and a backup procedure was developed. Instructions for updating Facility Graphics were also written.

The Aerostation functional documentation continues to be reviewed. Most of the graphics (cabinet layouts, floor layouts, etc.) have been generated and incorporated into the documentation.

Regulated Power, Uninterruptible Power, and VAC Power were put into the correct format and were reviewed. All facility drawings have been obtained and incorporated.

Patch Panels and Distributors was reviewed and converted to the correct format. All graphics will be generated and incorporated into the documentation.

Protective Relays has been reformatted and is now being reviewed. All facility graphics have been obtained and will be incorporated.

Functional documentation was developed for the System Information online software option. This option includes many of the features previously available under the obsolete Data Operator Menu as well as new options for cleaning up the temporary (_TMP) directory, resetting the current reading number, entering file transfer protocol information for a customer or ADA, notifying Test Article Graphics tasks to update at a fast rate, and notifying the test article data reduction software to update the ice bath correction values. All graphics have been generated and incorporated into the documentation.

Terminal Menu Task was updated to reflect the current online software. All references to the obsolete Customer Menu were removed.

The CRF and LAV technical specifications were updated to include information for all current software.

The following Facility Mechanical/Electrical Operations Hardware functional documentation was put into the correct format, updated with current information as it became available, and incorporated into the CRF functional documentation. (Mechanical Section --Cooling Water, Discharge System, Inlet, Test Article Support, Test Chamber, Variable Speed Drive Section --30 MVA Power Transformer, Overview, Process Instruments, Rotating Equipment, Solid State Exciters, Systems Operations). Data flow diagrams, block diagrams, cabinet layouts, and other graphics were designed and incorporated. Facility blueprints were obtained, updated as information became available, and incorporated. The Device and Instrument Lists were also copied and incorporated for historical purposes. These documents will be updated as corrected and/or finalized graphics, missing references, and answers are obtained.

The Electrical Power and Variable Speed Drive functional documentation was finalized and incorporated.

The Instrumentation Patch Panel blueprints continue to be redrawn in Micrografx Designer for incorporation into the facility functional documentation. The possibility of converting the blueprint CAD files to a PC-compatible format is being researched. Various other blueprints were also updated.

The FCC1 and FCC2 Calibration databases were documented and incorporated into the Databases and Commons book. Documentation for the Limit Check Termination Database was begun.

Documentation was also prepared for the Power Monitoring System, Channel Checks, Pressure Calibrations, ZADs, and Heise pressure controller operation and communication.

Drive Station was updated with a new appendix containing the parts list for the sweep generator.

<u>Online Documentation</u>

Research was performed to convert CRF written documentation to an online documentation system which could be accessed by CRF network PCs and Xterminals. The Netscape Communications server was acquired and installed to provide a Web service for the CRF. Software installation was performed to provide the basis for the CRF documentation intranet. Documentation hierarchy and menus required for the new online documentation system were developed. Newly released software is being researched to determine if the expanded capabilities better meet the needs of the TRC. Online documentation structures such as transparent Graphic Interchange Format (GIF) files and image maps were also researched for functionality and possible inclusion.

Security Documentation

Network and security documents were updated to provide comprehensive information about TRC security and then reconfigured to significantly reduce the maintenance effort for these documents.

User's Guides

Generating Campbell Diagrams for the Compressor Research Facility was enhanced with additional information. It includes instructions for setting up all hardware and software required to generate Campbell diagrams using online or playback data as well as instructions for printing a generated diagram.

The Test Group User's Guide was updated to include information about the latest software changes and enhancements.

The PC User's Guide was updated and distributed to users. A procedure to enable users to easily reduce the size of graphics incorporated into Word documents thus reducing the file size and speeding up the file printing time was added.

Trouble Logs -

Trouble Log -

Engineering Units software was modified to enable users to obtain the number and type of test article headers being used. A more reliable relative humidity calculation based on the measurements of the dewpoint sensor(s) and the inlet temperature was also incorporated.

Trouble Log -

VMS software was modified to increase the number of supported Xterminals from 28 to 100. This entailed making changes to the Master Control Program, Compressor Data Alphanumeric Display, Facility Information Display, IOTECH, Alarm Check, Test Operator Xterminal Control, and global common page section. An Xterminal was configured and installed in the first floor Signal Conditioning Room.

Trouble Log -

Promote DEFINE.FOR out of [COOMCJW.DEFINE]. Modify the program to place output files in _TMP and provide a path for the input files. APPL.MAKE also needs to be modified.

The software was modified and promoted. All code changes were documented.

Trouble Log -

The equipment custodian needs to use the LMCA computers. This requires TCP/IP to be installed locally. FEDLOG and the latest version of Access are also needed.

The PC system was upgraded from DEC Pathworks 4.1 to version 5.0 to provide TCP access; the PC was also set up to use the POTX NT server to access LMCA computers.

Trouble Log -

Currently the new value of DICECOR is stopped on command but it is not used until the online value is greater than 1.3° F. The value that is started on command should be used all of the time.

The data reduction software was modified to use the UTRTA (universal temperature reference temperature A) correction values to correct the UTRTA-*x* temperatures if those values are non-zero. Otherwise the software will use the calculated difference between the ice bath temperatures and the freezing point of water if that difference is less than .3° F. This results in the same value being used to correct the UTRTA-*x* temperatures for a compressor test rather than the changing value of ice minus the ice bath temperatures.

The test article data input was also modified so that the confidence headers DICECOR (delta ice correction) will be the ice bath temperature plus the ULTRA-*x* correction value minus the freezing point of water.

All software modifications were documented.

Trouble Log -

There is a significant amount of noise on the RTD channels measuring the UTR temperatures. This noise contributes to a temperature variation of ~ .6 to 1.0° F. One possible near-term solution would be to use a moving average of about 30 RTD readings as the RTD temperature value. This will reduce the RTD noise influence on the test article temperatures. This correction should be done on all UTR RTDs.

The engineering units conversion for ice point reference (EUCICE) software was modified to store the last 30 values for each of the 8 universal temperature reference (UTR) resistance temperature device

(RTD) temperatures. After 30 readings are stored for a channel, the software calculates an average based on these readings and then places this average in the value for the UTR temperature in the engineering units and corrected engineering units file structures.

The Test Article Data Playback, Test Article Data Reduction, and Engineering Units Conversion software was also modified to pass information about the current data point to EUCICE thus enabling EUCICE to determine if the data is from a static data point.

All software modifications were documented.

Appendix S

Delivery Order No. 19

Core Driven Fan (CDF) Test Support

Core Driven Fan (CDF) Test Support

Operator's notes were created to provide instructions for bringing up Xterminal 29 in the test chamber so that end-to-ends could be easily performed to verify channel readings.

Account request forms for CDF system access were distributed and collected.

Test Preparation

Battelle worked with government personnel to determine the number, location, and recording configuration for the high-response pressure transducers (Kulites) to be used during the CDF test.

The Monitor computer was reconfigured to use a non-removable disk for classified processing. Software and operator procedures were written to ensure the disk is write-protected in normal mode and Monitor functions that write to disk (e.g., power monitoring and test operator interface) were converted to VS4.

Specialized end-to-ends to test pressure configurations (TEPECs) were performed on the pressure system and Venturi pressure channels. Bad pressure system channels were determined and troubleshooting was begun on the bad pressure channels.

Based on meetings held to discuss the current condition of the CDF database and the patching difficulties encountered by the technicians, decisions were made to rebuild the CDF database to ensure accuracy and to implement a logical patching scheme to reduce physical patching difficulty. The technicians were instructed to patch the channels using a method that was easy for them to track and to report their progress on a daily basis. This information was entered into a spreadsheet. A copy of GE's instrumentation list was then obtained and the information was sorted by temperature, pressure, miscellaneous headers, and range. This list was merged with the information stored in the spreadsheet. Gains were assigned to each channel which would optimize channel accuracy without saturating the amplifier in the channel path. The spreadsheet was then converted to a text file and software was written to use the file to create measure and path cards thus generating the new CDF database.

A new Print Format 2 file was created which contains all valid pressure headers for the CDF test. The Test Article Data Reduction software searches this file to verify that a header is valid. When a valid header is found, a measured pressure header value is input.

Pressure System

As part of the investigation into the problem of head loss and its effect on the CRF's measurement of headers, an experiment was conducted on the effect of head loss. In this experiment, a barometer was moved from the first to the second floor of the Signal Conditioning Room; there was a .0086 psi difference in readings between the two floors. This difference verified the calculations made on head loss.

The layout of the pressure system for CDF was designed. A meeting was held to present this layout, discuss the reasons for re-plumbing the calibration lines, and recommend that the pressure system be moved to the Second Floor Signal Conditioning Room. Errors such as head loss and its impact on the calculation of mass flow were also discussed.

A job task was written to re-plumb the calibration lines of the Ruska pressure controllers. This effort resulted in an improved pressure system as the stabilization delay was decreased from 330 seconds to 70 seconds.

Venturi Transducers

A job task was written to create a climate-controlled box for the Venturi Druck transducers. Currently, the Venturi transducers are only partially climate controlled; they are heated but are not cooled. This task was discussed with the CRF technicians and a decision was made to monitor the Venturi Druck box temperatures during the CDF test and then use this information to decide whether to control the Druck's temperatures.

Trouble Logs

Trouble logs concerning the following topics were resolved. Consult the actual trouble logs in the CRF library for technical details.

Hardware

- Various ZOC problems were researched and resolved; Scanivalve connectors were installed.

- Critical channel and end-to-end problems were researched and channels were replumbed.

- Troubleshooting the Test Article Data Analog Input software revealed problems with the Presys hardware; it was returned to the manufacturer for repair and recalibration.

Software

- The CFLTCK (Clear Fault Check) routine on FCC1 was modified to limit-check all critical channels. Appropriate modifications were made to the limit-check database.

- A new user interface was added to the Test Article Data Acquisition Control software to enable users to save pressure calibration constants for individual headers and provides the option to save all pressure headers associated with a particular pressure controller.

- Help screens were added to the online software to document all new features added for the CDF test.

- Software used to create a patching schedule based on a previous test program was researched and all software problems were resolved. New software was written to cull temperature and pressure header names as well as their maximum range from a trial database. This information was used in conjunctions with the Define software to successfully create a database with new test header names.

- Diagnostic software was written to help debug Presys channels showing rare intermittent voltage spikes of up to 5 volts.

- New statistical headers were added to the test article database to allow pressure controller configurations to be changed easily by modifying the database rather than the software.

- Changes were made to the following Facility Graphics screens to accommodate the test. Appropriate software and documentation were updated for these changes.
  - AUX Air
  - CC Level Test
  - Critical Channels
  - SV/SB Channels 1-4
  - SV/SB Channels 5-8
  - SV/SB Control
  - TALO Return

- Variable Geometry (B&W)
- Hydraulics

- The CCLINK software module was modified to correct VAX-FCC1 link problems.

- Headers PADRSP and TADRSP were assigned as requested to amplifiers, and channels were hooked up on the test article.

- Limit-check and test article database modifications were made as requested.

- Temperature gains were modified as requested.

Appendix T

Delivery Order No. 20

GESFAR Test Support

GESFAR Test Support

GESFAR test support begun under Delivery Order #16 was continued under Delivery Order # 20.

Test Manning

Manning support was provided for the Software Engineer, Data Engineer, and Kulite Aeromechanics Engineer positions.

Software Engineer tasks included:

- Bringing the computers and links up.
- Establishing the links between the various computers (VS4 and ADA).
- Activating the communication link with GE.
- Entering the GE password and ensuring that data transferred correctly.
- Starting the application software on VS4.
- Troubleshooting computer, link, and device-related problems as they occurred.
- Assisting users with problems, printing and logging printouts, running backup jobs at the end of the test, and degaussing 4 mm tapes.
- Logging software changes.
- Transmitting data to GE.
- Shutting down the computer systems at the end of the test day.
- Deleting old historical files as necessary to free disk space.

Data Engineer tasks included:

- Performing ZADs, channel checks, and pressure calibrations.
- Troubleshooting out-of-tolerance and device-related problems as they occurred.
- Entering delete codes daily.
- Re-viewing instrumentation walk-around sheets daily.
- Entering offset values and assisting technicians obtain offset values.

Kulite Aeromechanics Engineer responsibilities included:

- Monitoring transducer signals to identify transients (e.g., stall).

- Supporting the Aeromechanics Engineer on data processing issues.
- Monitoring recorded signals to verify data integrity.
- Processing over-the-rotor Kulite data.
- Verifying the operability of all high-response pressure transducers.
- Controlling the acquisition of high-response pressure transducer data. This includes the acquisition of over-the-rotor Kulite data and operation of Kulite tape recorders.
- Continuously updating online notes concerning test conditions relevant to analog data acquisition and recording.
- Assisting in the recording and acquisition of online Campbell diagram data.
- Performing online analysis as required. This includes determining such things as the type of stall (rotating stall or surge), the stalling stage, and amplitude of the pressure disturbances.

Over-The-Rotor (OTR) Kulites

Pretest And Experiment Design

As required by GE, preparations were made to run the GESFAR test with casing mounted Kulite pressure transducers located over-the-rotor tip and referred to hereafter as over-the-rotor (OTR) Kulites. The original requirement was to run these with the GESFAR rotor only. The Air Force extended this requirement to cover all of the rotors tested and most of the casing configurations.

GESFAR w/ Tip Treatment - 12 Kulites

FDA w/ Tip Treatment - 14 Kulites

GESFAR w/ Smooth Case - 16 Kulites

FDA w/ Variable Tip Clearance - 16 Kulites

Setup

The OTR Kulites were installed in a "Kulite Block" which conformed to the shape of a rectangular hole cut into the case of each test article. In this manner, the Kulites could be quickly installed or removed to facilitate different test requirements by simply inserting or removing the Kulite Block. The Kulite Block for GESFAR w/ Tip Treatment was provided by GE. At Battelle's recommendation the 25 psid Kulites provided by GE were not used, but were replaced with Air Force provided 15 psid Kulites. Three additional Kulite Blocks were required since the smooth case block could be used for the smooth case test. One of these, the smooth case block, had already been built and used for the ADLARF test program. The FDA block with tip treatment was designed by the Air Force and Battelle; Air Force machinists then built it. The block for the variable tip clearance study was designed and built by the Air Force exclusively.

Instrumentation of the GE-provided GESFAR block and the FDA w/ Tip Treatment block was performed by Air Force instrumentation technicians and engineers with Battelle consultation as required. Because of a design flaw with the GE-provided GESFAR block, Battelle requested that an additional Kulite be installed forward of the block position to facilitate pressure measurements ahead of the leading edge. The forward-swept nature of the GESFAR rotor also required additional Kulites to be installed forward of the block position for the smooth case. This was accomplished by Air Force personnel with Battelle consultation. The variable tip clearance block was instrumented by Air Force personnel with minimal consultation from Battelle staff.

Changes in Kulite sensitivity due to installation stress and temperature change required that the transducers be calibrated online to ensure measurement accuracy. To accomplish this, the reference sides of the OTR Kulites were plumbed to the pressure controller system used to calibrate the CRF low-frequency response pressure transducers. By changing the reference pressure during compressor operation, the pressure difference across the transducer measurement surface is changed even though the compressor operating point is held constant. Calibration coefficients can therefore be calculated by assuming transducer linearity. All of the rotor 1 OTR Kulites were plumbed directly to a pressure controller by Air Force personnel under Battelle consultation.

Low-frequency response static pressure data from the online Data Acquisition System (VS4) was also required for OTR Kulite data acquisition for mean pressure estimates and the online Kulite calibration procedure. Required data channels were identified by Battelle, and the hardware and computer database were configured by the Air Force. Battelle routinely verified that these channels were in operation for all portions of the test where OTR Kulite data was required.

OTR Data Acquisition Control software written and managed by Battelle was used to accomplish test requirements. Most of the software resides and operates on ADA, but a large portion of the software exists on the online Data Acquisition System. The tip geometry of each rotor (GE provided), position of each Kulite relative to the tip leading edge of the blade (GE and Battelle provided), and digitization parameters (Battelle provided) were required by the software. The software was written to accomplish two specific tasks: to conduct online calibration of the Kulites, and to acquire and process the Kulite data at specific operating points defined in the test plan. Battelle prepared the ADA software and required parameter files. Online data acquisition software was also written to send static point pressure data to ADA and to control the pressure controller used to calibrate the Kulites online.

Testing

Four Kulite transducer configurations were used during the test: GESFAR Rotor w/ Tip Treatment, FDA Rotor w/ Tip Treatment, GESFAR Rotor w/ Smooth Case, and FDA Rotor w/ Variable Tip Clearance. All totaled, over 400 data points have been recorded and over 183 points have been scanned online. These figures will probably increase significantly. Further details will be included in the final test report.

Instrumentation problems such as bad amplifiers, failed Kulites, and bad connectors were identified. All were addressed by Battelle, SelectTech, and Air Force engineers and technicians. The number of plotfiles produced by the software exceeded the preset amount originally allowed by the software; this was resolved.

Laser Anemometry

Pretest

In the CRF, velocity measurements inside the blade passages of rotating compressor rotors are facilitated by laser anemometry. The system at the CRF is a two-component setup using a fiber optic probe to project and receive the laser light. The probe is mounted in a traverse system with four degrees of freedom which allows the beams to be positioned nearly anywhere in the blade passage through a quartz window mounted in the compressor case. The flow is seeded with very small particles (usually glycerin). The laser light is reflected off these particles and received by the probe. The resulting light pulses are carried back through the fiber optics to two sophisticated spectrum analyzers. Frequency and timing information is passed to a VAX computer (LAV). The frequencies are interpreted as velocity data while the timing information is translated into position data. The resulting data is then used to produce contour plots showing the velocity fields inside the compressor rotor blade passage.

For the GESFAR test program, laser anemometry measurements were required by GE and the Air Force during testing of the actual GESFAR rotor. These measurements were acquired through a window located over the first stage rotor tip. Data from two operating points, peak rotor efficiency at 100% and 90% speeds, was acquired. Later, a requirement for measurements from the FDA rotor during the variable tip clearance study was set by the Air Force. Data from two operating conditions, 100% and 85% speed at peak rotor efficiency, was acquired for this study.

Testing

During the test program, one of the two components did not work correctly. No reason for this has yet been identified; however, the possibility that it was caused by software problems has been eliminated.

Testing continued after the software was modified for single component acquisition. Test position manning support was also provided for this system. Data for the GESFAR rotor has been acquired and is being reduced as time permits.

Testing of the FDA rotor for the tip clearance study was completed. Most of the data acquired has been high quality and will be presented in varying detail in the GESFAR final test report.

Problems

- The traverse system did not work initially. Troubleshooting was hampered by previous hardware modifications. Since duplicate but unmodified traverse control and position indicator hardware was available, it was used instead. The software required minimal changes.
- The method by which the software relates the direction of rotor rotation to the data was modified. Previously, the geometry files were altered so the software "thought" the rotor was rotating in a specific direction. This was changed so that the user must now specify the direction during the reduction process.
- The blue laser component provided little or no data rate during the test program. Although the reason remains unclear, it has been theorized to be an optics problem. To continue testing, a software option was added to allow single component data acquisition. The green component acquires measurements at 2 different angles 90 degrees apart. The two measurements are now combined in the software to provide two dimensional data.

Stall Detection And Analysis

Battelle worked with Air Force engineers and technicians in a consultation roll regarding all of the high-frequency response pressure transducers on the GESFAR test article. Recommendations and assistance were designed to fulfill the following requirements:

- Transient data for OTR Kulite analysis.
- Transient data for stall precursor analysis.
- Stall monitoring and characterization during and after testing.

Online Campbell Diagrams

The ADA online Campbell software was recovered and reconfigured. One module performs the actual data acquisition and produces a single plot in real time; another takes the acquired data and produces any number of required plots. In general the software worked without significant modification, but the user interface and the program setup procedures were inadequate. A graphical user interface was written for both modules. A better parameter setup procedure using namelists was created and an improved directory structure with a final goal of having a software management system similar to that on the CRF VMS systems was set up.

System hardware was researched and configured; the proper settings for the speed encoder and the spectrum analyzer were established.

To date, at least 24 transients have been processed into Campbell diagrams. Details will be included in the test report.

Problems involving the software's ability to track the rotor speed correctly at high speed were encountered. This adversely affected Campbell diagram generation. The problem was solved using the 6/rev signal off the drive shaft instead of the 1/rev signal off the gear box.

GESFAR Clean Inlet And Distortion Data

Processing of the data acquired during the clean inlet and distortion mapping portions of the GESFAR test was begun and 48 over-the-rotor scans were reduced and plotted.

GESFAR Tip Clearance

Data acquired during the tip clearance study portion of the GESFAR test was processed. There were 135 over-the-rotor (OTR) scans reduced and plotted as well as 33 laser anemometry scans reduced of which 3 were plotted. An analysis of the OTR data was performed and will be included in the test report. The data was given to the Air Force for continued analysis.

Data Analysis

Tracking the ZOC box temperatures during ZADs for one month revealed that the box temperature only varied by one degree and this variance falls within acceptable tolerances. The ZAD configuration was also tracked during the GESFAR test.

ZADs obtained during one three-week period were reprocessed with the playback software and the pressure headers that went into the calculation of massflow and efficiency were dumped to a data file. This file was imported into Excel for statistical analysis. Certain headers were plotted as a function of psi versus days. From this analysis, it was determined that the Ruska controllers were not accurate due to a control volume problem which was resolved by switching to smaller diameter tubing. The ZADs were also divided into early and late groups. This analysis also revealed that the early ZADs were typically more accurate than late ZADs and the situation is being researched.

Trouble Logs

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The Test Article Database Generator software was modified to initialize Critical Channel low and high alarm action codes.

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A test was performed on the data processing code to show calculated values for slope and offset (new and old) as well as engineering units from counts using the channel check slope and offset. Various improvements were made based on the test results:

- All channels more than 50 counts from full scale on the level 2 static data point are flagged bad.
- The averaged low counts comparison with 0 was changed from 200 to 25. All channels more than 25 counts from 0 on the level 1 static data point are now flagged bad.
- Software modifications were made to compare new high counts minus new low counts with old high counts minus old low counts not greater than 10. The software had been using a slope deviation greater than .5.
- Software modifications were made to compare new low counts with old low counts not greater than 10 rather than using an offset deviation greater than .05.
- Percent change calculations software was removed since it was never used.
- The channel check printout was modified to include delete code reasons.

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A problem was encountered with the translation of data concerning latch bits from the Program Logic Controller (PLC). The logic was explained and determined to be correct.

The Drive Lube Oil supply pressure high warning value was increased from 50.00 to 52.00 to eliminate duplicate warning messages on the Event Logger. Software was modified to show this value as the limit in the graphics. A database copy was generated.

The Oil Temperature header on TALO Supply (Screen 17) showed a temperature of 86.2 degrees in a low warning fault condition (a low warning fault occurs at 45 degrees). The problem was traced to an incorrect scale factor in the limit-check database which was corrected. A new database was generated.

Low Speed Gearbox RTD-128 read 10 degrees Fahrenheit too high; the channel was recalibrated to correct the problem.

The number of variable geometry devices changed when the Inlet Guide Vane (IGV) was removed from the test article. This required modification of the Stator Vane 1 schedule as well as various screen and software modules.

- Screen changes were made to SV/SB Control (Screen 13), SV/SB Channels 1-4 (Screen 40), and Variable Geometry (B/W) (Screen 44) to eliminate the IGV and reassign Stator 1 to a new schedule.
- The IGV information was deleted from the Control Computer Link software and Test Article Data Input data file. IGV feedbacks were removed from inputs for headers TAMOVING and TATRANS.
- The facility database was modified to accommodate screen changes as well as changes in executable software. The Facility Information Display and Facility Reduction software was modified to accommodate changes in the database and the number of SV/SBs.

The 12.4 motor showed a high rotor temperature when it received a power spike. Filter software logic was created so that values are averaged to diminish the effect of a spike. A warning is set if the average falls outside the acceptable range. Logic to prevent overflow or negative temperatures was retained.

The PDV (differential pressure headers for the Venturi) exhibited inaccurate readings for all points during pressure calibrations (PCALs); however, ZADs passed.

The time for the channels to reach stability was increased so channels on controllers 1 and 2 could be pressurized. This did not affect the PDV headers; it corrected many other headers that failed the PCAL. The PDV header problem was caused by the assignment of the PCAL headers; either the range or the magnitude was out of range for these headers. The problem was solved by modifying the Test Article Data Input file and the Print Static and Test Article Data Control software to assign a lower maximum value and smaller range as new setpoints for these headers.

TAC1 IOIS problems were traced to the Expander 1 chassis. Voltages were checked at the chassis and at the controller, control logics for the rack were swapped, and cards were backed out to see if they were placing an error into the backplane. A work-around solution was obtained by swapping the Analog Output (AO), Digital Input (DI), and Digital Output (DO) cards and then modifying the software to accommodate the addresses of the new cards.

TAC2 IOIS problems were traced to the Expander 0 chassis. A temporary solution was obtained by relocating the AO and DI cards and then modifying the software to accommodate the addresses of the new cards.

Permanent solutions included repairing a bad power supply in the TAC1 IOIS and removing a bad AO card in TAC2 IOIS which caused the power supply in the rack to fail. Software was modified as appropriate.

The scale factor in the Monitor Modify Database (MDB) routine was modified so that when the new data for Peak Month-To-Date is entered from the Test Operator's Station, the correct value will display on Power Demand (Screen 39) and on the Test Operator's serial port monitor.

An option was added to the Test Article Data Control Menu to control the Rotadata touch probes. When the option is enabled, the clearance software will take clearance measurements with a static data point. The clearance software is started and the rotor speed is checked. An error message occurs if the software was not started or the speed falls between 0 and 6100 RPM.

Several new routines were added to the clearance software:

- Steady State Point automatically initializes the RCMS-4 units after the rotor speed has been checked.
- End of Static Point automatically parks the probes after the data is taken.
- Verify checks for each character returned from the RCMS-4 units concerning the current probe position. If the value is out of range, the Reallocate routine is called to reallocate and reassign the channels in an attempt to clear the errors.

Additional subroutines were written to allow users to delete specific clearance headers and to automatically update the clearance display screen when headers are deleted.

Software changes were made to accommodate the re-installation of the Inlet Guide Vanes (IGVs) on the test article. These changes included:

- Modifying the Critical Channels Link Headers data file so the SV/SB 2 feedbacks go to the correct headers.
- Modifying/remodeling SV/SB Control (Screen 13), SV/SB Channels 1-4 (Screen 40), Variable Geometry (B/W) (Screen 44), and their associated data files.
  - -- Screen 13 was changed to accommodate the new range and schedule. New schedule data was added for SV/SB 2.
  - -- Screens 40 and 44 were remodeled and SV/SB 2 data was added.
- Modifying the Facility Information Display and Facility Reduction software.
  - -- The facility information database was modified to enable SV/SB 2 to be plotted.
  - -- New headers for SV/SB 2 were added to the facility database and calculations were made for SV/SB 2 in the Facility Reduction software.

All changes were properly documented; the software was tested and promoted.

Two pressure headers in the test article data input database had been swapped; they were returned to their original signal paths. The test article database was updated with this information.

The safe schedule for SV/SB 1 in the test article peculiar database was also redefined as requested. Facility Graphics SV/SB Control (Screen 13) and its associated data file were modified to accommodate the change in SV/SB schedules. An error made in setting up the test article peculiar database which caused the values to not load properly was found and corrected.

All changes were properly documented and the software was tested and promoted.

When the base peak month-to-date (MTD) power usage value was changed, Base Peak MTD on Power Demand (Screen 39) displayed an incorrect value. The problem was researched and the scale factor for the base peak month-to-date was modified in the Monitor routine MDB to correct the problem. Since MDB is called by the Monitor program TCP, both were recompiled after all changes were completed. All changes were properly documented; the software was tested and promoted.

It was discovered when a user tried to locate the current test data file to use for Facility Plotting that the data had been appended to the previous day's data file. This problem occurred when the Computer Operator failed to log off as CRFOPR at the end of the previous run day. Since the online software was designed to set up the new test day data file information when the CRFOPR user logs in, failing to properly log out as CRFOPR caused the data to be appended to the previous day's data file. The software has been modified so that a message requesting the operator to check the value of the current date displays when the Facility Graphics data reduction software is initiated. If the value of the current date does not match the actual date, the operator simply logs out and then logs back in to initialize the software to the correct date.

Speed control trim rates were increased in magnitude to decrease the time permitted for the frequency converter to remain at the fringe of the deadband area. Allowing the frequency converter to remain too long in the deadband area causes the facility to E-trip.

Facility headers ZRE-02 and -06 as well as RTD-19, -27, and -128 were disabled as requested. The limit-check database was modified and regenerated. A copy of the new database was placed at the Facility Engineer's Station.

Additional headers PCARB1, VABRGT, VHBRGJ, VVBRGJ, VHS1, and VVS1 were disabled as requested by modifying the CFLTCK (clear fault check) routine to allow an array containing these channels to be eliminated from limit checking. The values will still display, but limit checking will not be performed. The software was tested, compiled, and linked.

The following Facility Graphics screens were modified to display the state of the disabled headers.

- Low Speed Gearbox - Temp (Screen 32)
- High-Speed Gearbox - Temp (Screen 34)
- Pedestal - Vibs (Screen 35)
- Pedestal - Temp (Screen 36)
- Critical Channels (Screen 50)
- CC Level Test (Screen 53)

The Build Info Window routine was also modified, re-compiled, and re-linked so that the modified information would display when requested.

All changes were documented, tested, and promoted.

The clearance software was modified so the screen button changes color when an option is selected. A two-second button delay was also incorporated into the software to prevent system lockups which occurred when a button was pressed too rapidly. Additional modifications were made which permitted the offset values to be entered as type 29 constants thus eliminating the problem of constantly modifying the code to change the offset values.

ZOC boxes 3 and 5 were plumbed together after all pressures on ZOC box 5 failed the early ZAD by about 0.2 psi indicating a pressure controller problem. Further proof that the pressure controller had fallen out of calibration was obtained by taking Heise 5 out of calibrate mode and putting it in measure mode; Heise 5 measured atmosphere 0.2 psi low. Heise 5 was replaced with Heise 3 to resolve the problem.

When Heise 3 failed, it was replaced with a 0-50 psi Ruska pressure controller. Software settings were modified and the controllers were re-cabled in the First Floor Signal Conditioning Room to accommodate this change. When an attempt was made to perform a ZAD, however, the Ruska failed to pressurize correctly. It was finally determined that this problem was caused by an open valve internal to the Ruska controller and after it was closed a ZAD was performed effectively.